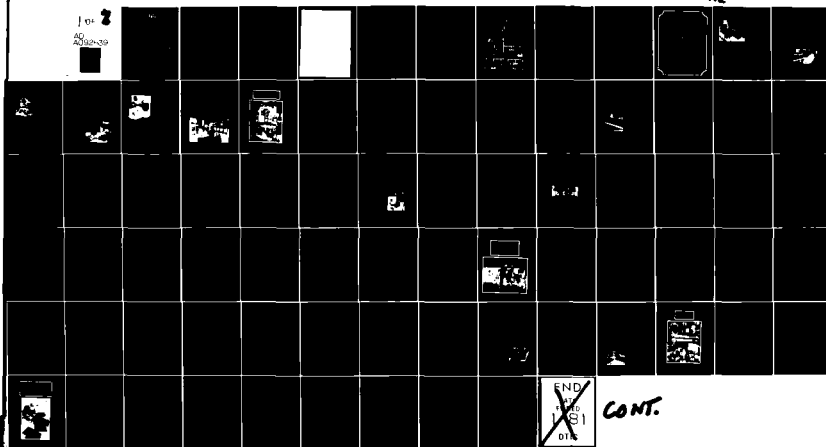


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AIR FORCE HUMAN RESOURCES LABORATORY  
ANNUAL REPORT - FISCAL YEAR 1979

Prepared by

Robert L. Denton

APPLICATIONS AND LIAISON OFFICE  
Brooks Air Force Base, Texas 78235

September 1980

Final Report



Approved for public release; distribution unlimited.

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AIR FORCE SYSTEMS COMMAND  
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This report was submitted by the Applications and Liaison Office, HQ Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base, Texas 78235.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

WILLIAM C. DEBOE, Colonel, USAF  
Chief, Applications and Liaison Office

RONALD W. TERRY, Colonel, USAF  
Commander

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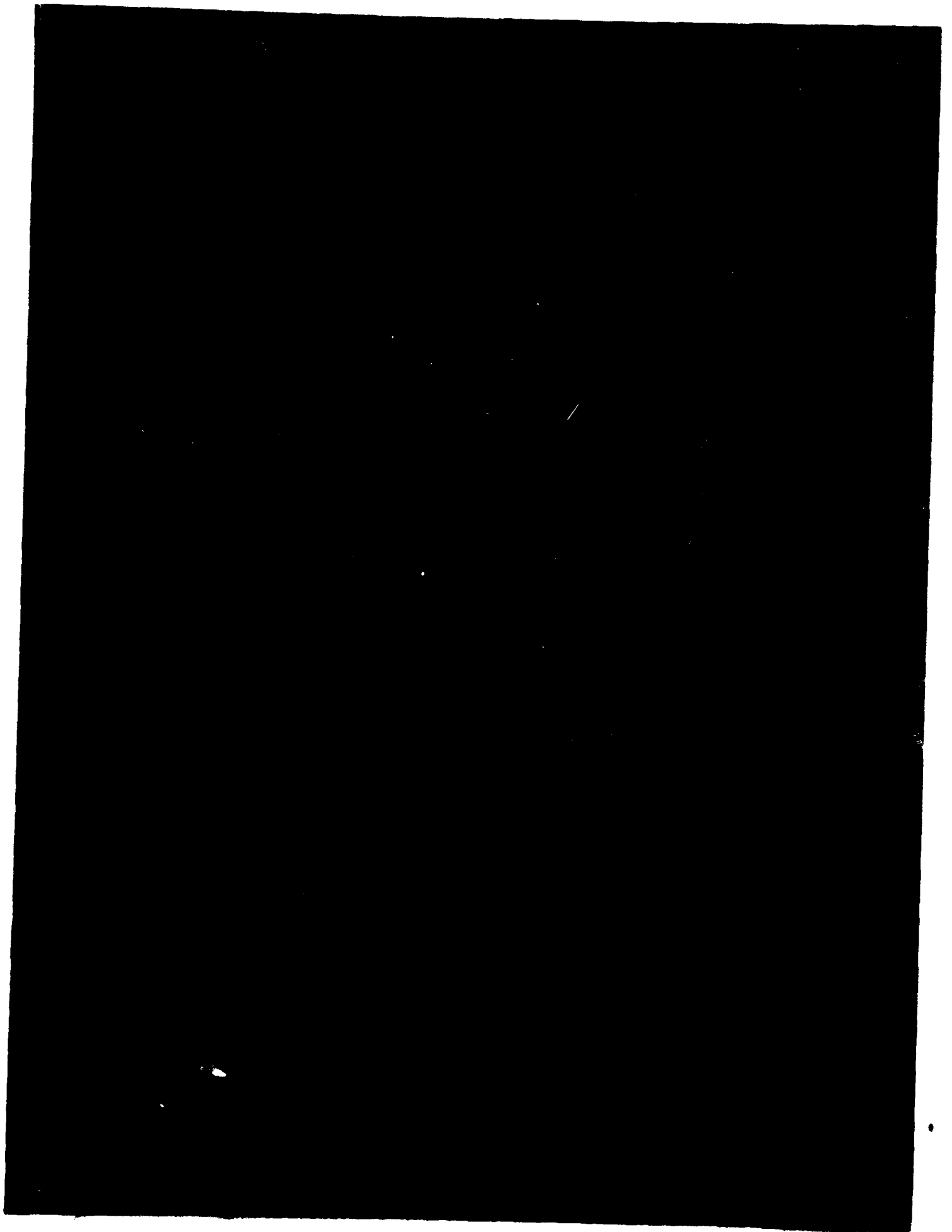
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## MESSAGE FROM THE COMMANDER

The research and development program of the Air Force Human Resources Laboratory provides a training and personnel technology base for Air Force use. This program, along with those of our sister Services in Defense Training and Personnel Technology, can contribute substantially to military supremacy and Air Force success. Indeed, the success or failure of human endeavors, whether military or not, depends not only upon the facilities, tools, and equipment provided, but also upon the skills and performances of the humans who make the systems work.

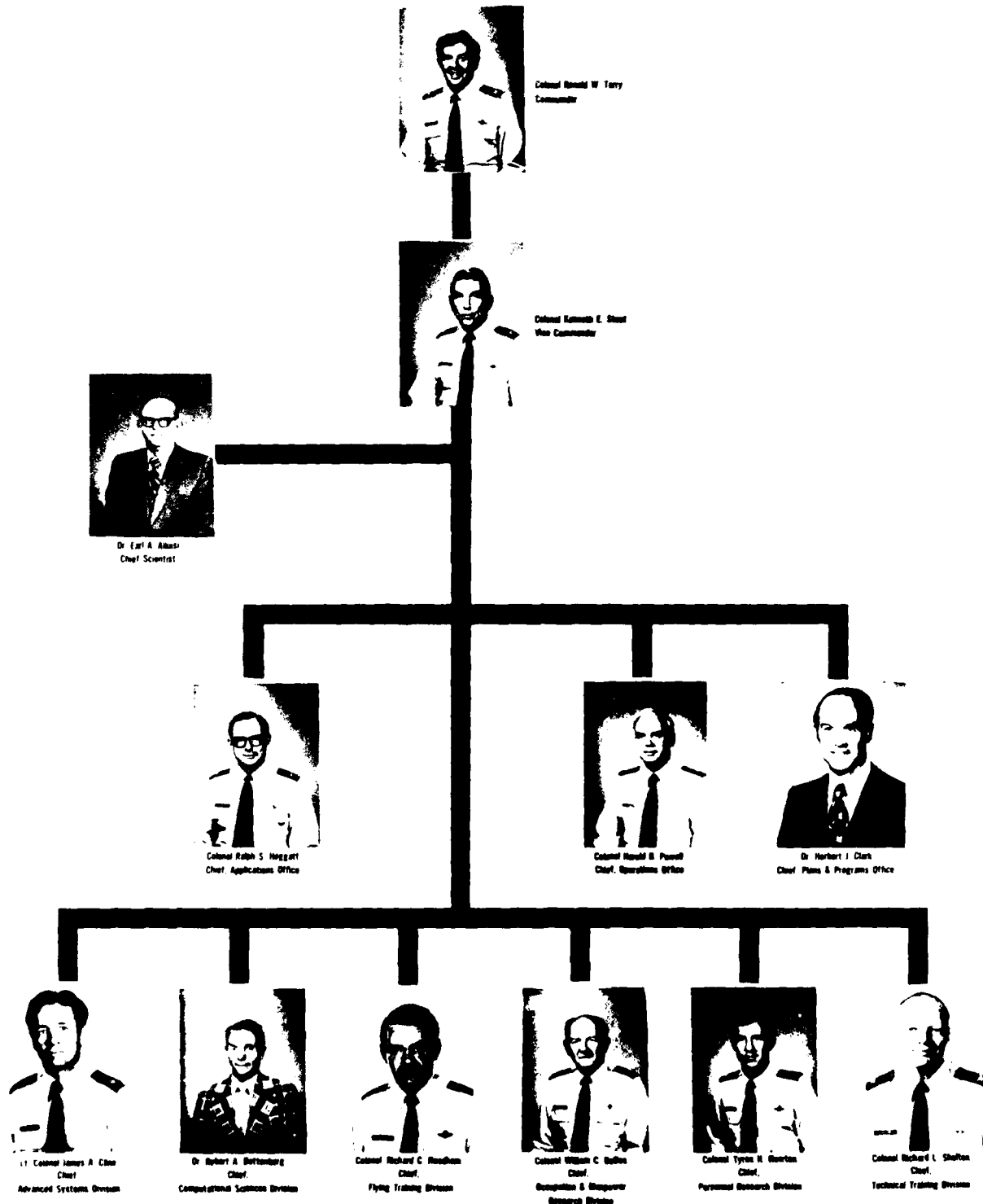
Progress is a continuous and dynamic process. Yet, it often appears discrete and static when reported. Many of the changes that have taken place during the last year are understated in this report. Many of those changes will appear to be overstated in next year's report because the organizational changes given then will reflect the major program restructuring that began during 1979 and that will be completed during 1980.

This annual report highlights some of the features of our organization, programs, on-going research and development projects, and accomplishments of fiscal year 1979. But it does so in the manner of "a captured moment of time." You—our sponsors, customers, and others—are invited to visit and become better acquainted with our real progress and the dynamic program that is the substance of the Air Force Human Resources Laboratory.

  
RONALD W. TERRY  
Commander

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# AIR FORCE HUMAN RESOURCES LABORATORY ORGANIZATION





## MISSION

The Air Force Human Resources Laboratory (AFHRL) is the Air Force Systems Command's organization charged with planning and executing the USAF exploratory and advanced development programs for personnel selection, classification, and retention; force structure and utilization; education, training, and instructional strategies; training technology for simulators and instructional devices; performance evaluation; and human resources data in system design and operation. The Laboratory provides technical and management assistance in support of studies, analyses, development planning activities, acquisition, test, evaluation, modification, and operation of aerospace systems and related equipment.

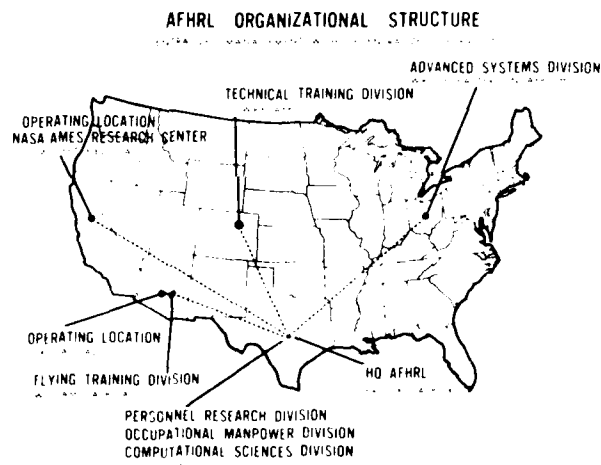
The AFHRL mission is broader than those of most other technology laboratories of AFSC. The hardware laboratories are almost entirely concerned with technological development; but hardware technology development is only one of the responsibilities of AFHRL. Of equal importance in AFHRL's mission is the development of information for uses in making management and policy decisions on selection, training, and personnel matters. This effort in human resources technology is most important because the largest single item in the Department of Defense budget is the cost of personnel and the associated costs of training and administratively supporting the personnel force.

## ORGANIZATIONAL STRUCTURE

The Air Force Human Resources Laboratory (AFHRL) consists of a headquarters, six divisions, and two operating locations. The Laboratory is structured for centralized management with decentralized operations. The research and development program of the Laboratory is centrally managed by the headquarters staff located at Brooks AFB, Texas. The divisions perform the research activities and to a great extent are collocated with major users of the Laboratory products and services.

Collocation of research facilities with the users of the research and development (R&D) product has many advantages. It allows for maximum interaction and communication between the research scientist and the operational military manager. It permits better understanding of the environment and problems faced both by scientist conducting the research and the military manager implementing the results of the scientific study. Close working arrangements generate mutual support and produce technology transfer with minimum delay. Often, collocation produces real economic saving through mutual use of equipment and personnel by the research scientist and the operational organization. This is especially true in the area of flying training.

The six divisions of AFHRL are the Advanced Systems Division at Wright-Patterson AFB, Ohio; the Personnel Research Division, the Occupation and Manpower Research Division, and the Computational Sciences Division at Brooks AFB,



Texas; the Flying Training Division at Williams AFB, Arizona; and the Technical Training Division at Lowry AFB, Colorado.

In addition to the six major divisions, AFHRL has established two operating locations. One is at NASA-Ames Research Center, Moffett Field, California and was established to coordinate research in full-mission flight simulation and flight management systems. The other operating location is at Luke AFB, Arizona; one of its missions is to conduct research with the Tactical Air Command on simulation training for air-to-air combat.

## PREDECESSOR ORGANIZATIONS

The Air Force Human Resources Laboratory (AFHRL) was established in July 1968; however, some of its research areas span almost four decades. Since the Laboratory frequently receives inquiries concerning technical reports published before and after 1968, this chronology of predecessor organizations of AFHRL is provided to trace the origins and continuity of various research programs and documentation. Briefly, the four major predecessor organizations were the Psychological Research Units (PRUs); Human Resources Research Center (HRRC); Air Force Personnel and Training Research Center (AFPTRC); and Personnel Research Laboratory (PRL).

One of the first PRUs in the Army Air Force was PRU Number 2, activated 15 November 1941 at Kelly Field, San Antonio, Texas. PRU Number 1, previously established at Maxwell Field, Montgomery, Alabama, ceased functioning in July 1942. On 4 July 1942, PRU Number 2 was transferred without change in duty location (Kelly Field) to the command of the newly formed San Antonio Aviation Cadet Center (SAACC), which is now Lackland AFB. In September 1942, PRU Number 2 was moved to SAACC and in October 1944, PRU Number 3 at Santa Ana, California, merged with PRU Number 2.

On 1 July 1945, the Department of Records and Analysis, AAF School of Aviation Medicine (SAM) was activated. With the inactivation of PRU Number 2 on 30 June 1945, one of its major groups, the Division of Records and Analyses, was transferred to HQ AAF Central Flying Training Command, Randolph Field, Texas. Personnel from this group were placed on temporary duty (TDY) to the SAM department located at SAACC. In March 1946, the Department of Records and Analysis, AAF SAM, was moved to Randolph Field and incorporated into the SAM Statistical Laboratory. On 1 May 1946, the Indoctrination Division, Psychological Research and Examining Unit (PREU) was established at the AAF

Military Training Center (MTC)—now Lackland AFB. This unit was formed from the Medical and Psychological Examining Unit Number 6, previously located at Keesler Field, Mississippi. In addition, on 13 January 1947, the Aviation Psychological Research Unit Number 1 (formerly the Psychological Research Project—Pilot) at Randolph Field was merged with PREU at AAF MTC. The PREU was redesignated the 3309th Research and Development Group in August 1948; in December 1948, the designation was changed to Squadron.

In July 1949, HRRC, Air Training Command, was established with the 3309th R & D Squadron incorporated into it as the Personnel Research Directorate. This directorate was redesignated as PRL on 1 June 1951. HRRC was transferred on 1 April 1953 to the Air Research and Development Command (ARDC)—now Air Force Systems Command (AFSC).

AFPTRC became operational 1 February 1954, replacing HRRC. AFPTRC also included the Human Resources Research Institute (HRI) from Maxwell AFB and the Human Factors Operations Research Laboratory (HFORL) from Bolling AFB. On 2 March 1956 at the direction of HQ ARDC, "Research" was dropped from the name of the Laboratory. The Personnel Laboratory, AFPTRC, was subsequently redesignated and assigned as Detachment Number 1, Wright Air Development Center (WADC). AFPTRC was disestablished 15 April 1958.

The Personnel Research Laboratory (PRL) was established as an element of the Aerospace Medical Division (AMD), AFSC, on 1 January 1962. PRL, located at Lackland AFB, continued until July 1968, when AFHRL was established with headquarters at Brooks AFB, Texas. Three of the AFHRL divisions remained at Lackland AFB until April 1977, when they were colocated with AFHRL headquarters at Brooks AFB.



# **AFHRL DIVISIONS**

## ADVANCED SYSTEMS DIVISION



Eye view monitor being used to measure eye movement during observation of computer generated images. This technique is used for comparing eye movement strategies with real world and emulated images of forward looking infrared (FLIR) and low light level television (LLLTV) sensors.

The Advanced System Division contributes to the development of advanced Air Force systems and operations through research, exploratory development, and advanced development. Major efforts deal with acquisition logistics, maintenance performance, ground operations training and engineering techniques for training simulators.

Acquisition logistics include research and development to improve technologies for incorporating logistics factors into the design, development, evaluation, and life cycle costing of Air Force weapon systems. The techniques of operations research, human factors, management science, behavioral science, and systems technology are applied to improve the capability to integrate logistics factors into Defense Systems Acquisition Review decisions; to assess alternative system designs and predict logistics resource requirements; to accomplish the logistics support analysis (LSA); and to quantify interactive relationships among the integrated logistics support (ILS) elements.

The maintenance performance area includes research and development programs to improve the effectiveness and efficiency of personnel and organizations responsible for the maintenance of Air Force weapons systems and support equipment. Programs involve the development

of improved techniques in the areas of personnel utilization, training, job aiding, maintenance management, maintenance policies and procedures, and organizational structure. A major current project deals with the development of a computer-based technical order system.

The ground operations area consisted of research, exploratory development and advanced development of techniques, methods and devices for evaluating and improving the performance of personnel who operate/control ground based aeronautical, missile, and electronic weapon and support systems. Special emphasis is given to the performance of teams, crews and units. Research in this area will develop and demonstrate techniques and devices for evaluating the performance of ground operator teams and crews. It will also determine the impact on performance of such factors as personnel policies, training, operational procedures, environmental factors and organization policies.

The training simulation area deals with such things as electro-optics, computer generated imagery, and motion cues for flight simulators that are realistic yet cost-effective. This area will eventually be transferred to the Flying Training Division of AFHRL.

## COMPUTATIONAL SCIENCES DIVISION

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The Computational Sciences Division operates the AFHRL scientific research, mathematical, and statistical computer data processing center in support of the other Laboratory divisions. It designs advanced rapid retrieval techniques for data bases and provides statistical analyses of personnel and training research data for a variety of agencies.

The Computational Sciences Division has developed a series of data bases containing information on personnel and training systems. The data bases are stored on magnetic tape. Software to process, organize, and display selected information from a single data base and to consolidate information on a common subgroup from two or more data bases has been implemented. The data bases include records on all active duty Air Force enlisted and officer personnel at 6-month intervals; Air Force Reserve and National Guard personnel; records of graduates from basic military training, technical training,

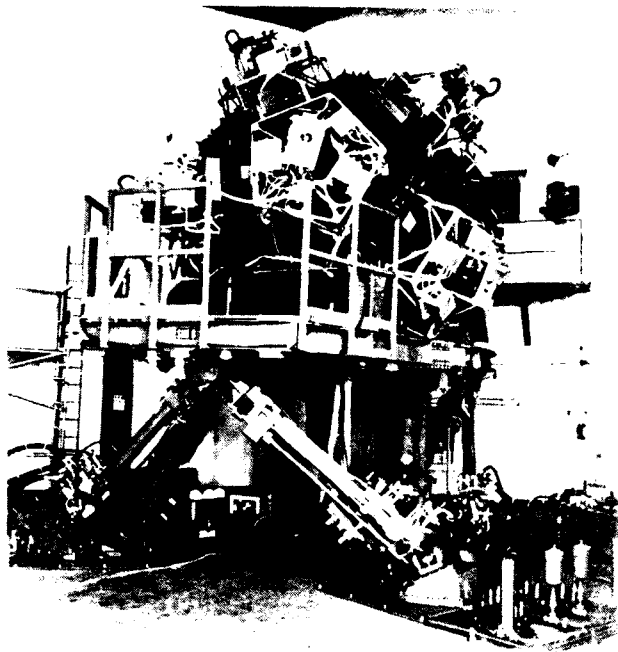
and flying training programs, and from the Officer Training School and Reserve Officer Training Corps commissioning programs; and records reflecting separations and losses from active duty. Special purpose longitudinal files have been derived from these data bases. These longitudinal files significantly reduce data processing requirements in many personnel and training research studies.

The Computational Sciences Division develops statistical and mathematical procedures to analyze data arising in research projects throughout the laboratory. Special techniques have been implemented to analyze the psychometric characteristics of aptitude, interest, and attitude tests and questionnaires. Other techniques have been developed and programmed to combine background information optimally; analysis using these methods are used to improve Air Force personnel selection and assignment procedures.

The modern scientific data processing center of the Computational Sciences Division provides statistical analysis and computational support to AFHRL divisions and various other agencies.



## FLYING TRAINING DIVISION



The Advanced Simulator for Pilot Training at Williams AFB is a marvel of technology and has been effectively used both in research and training. Originally configured as a T-37B aircraft, the system has been modified to train pilots transitioning to the A-10 aircraft.

Responsibility for research and development in flying training technology for AFHRL resides with the Flying Training Division. This division develops, tests, and evaluates existing and newly-developed hardware, programs, procedures, and techniques for improving all phases of flying training programs. The Division is collocated with the Air Training Command (ATC) at Williams AFB, Arizona, and has an operating location at Luke AFB, Arizona, with the Tactical Air Command (TAC). The Division facilities are accessible to the Air Force flying commands (ATC, TAC, Military Airlift Command, and Strategic Air Command) and serves the Navy and Army as well. The close proximity to the Gila Bend Gunnery Range, Tactical Fighter Weapons Center, and the Air Force Flight Test Center enhances its interface with the operational community.

The Flying Training Division operates the Advanced Simulator for Pilot Training (ASPT) and conducts studies to exploit simulator capabilities for improving flying. ASPT is the Air Force's most advanced and sophisticated simulator developed for aircrew training and research. Originally configured

as a T-37B aircraft, the simulator system has been modified to simulate the A-10 aircraft and is now being modified to simulate advanced aircraft, such as the F-16. Using the advanced simulator, the Division conducts research to define simulation equipment and techniques which may lead to improved training transfer and better operational simulators.

The Division is conducting research in flying skills maintenance and reacquisition, low level navigation, air-to-air refueling requirements, air combat maneuvering, air-to-ground continuation training simulator visual and force cue requirements, crew coordination, operational test and evaluation, and A-10 and F-16 syllabus effectiveness. The Division is also helping accident boards simulate the conditions of aircraft accidents to improve the data on which their findings are based.

In the future, the Division intends to assist the operating commands in tactics research. Simulation research is planned to determine the requirements for simulating the NATO scenario and wartime missions to increase the USAF force readiness.

## OCCUPATION AND MANPOWER RESEARCH DIVISION

The Air Force has 550,000 members and thousands of jobs ranging from cook to computer specialist, from auto mechanic to aerial gunner, and from personnel specialist to munition expert. Matching the right person with the right job requires job analysis and individual qualification assessment. The AFHRL division responsible for research to improve work force utilization and management is the Occupation and Manpower Research Division.

The Occupation and Manpower Research Division conducts studies on methods for collecting, analyzing, and modeling occupational information; structuring work into jobs, specialties, career ladders, and broader management categories; and establishing grade, pay, training, education, experience, and other job requirements. The Division does research which focuses on determining characteristics of jobs, developing methodologies to apply occupational data to training and instructional systems, evaluating the impact of transferability on

performance and classification structures, and developing the capability to identify skill deficiencies and organizational problem areas.

This Division has developed a computer-based Person-Job-Match (PJM) System that has been operationally integrated in the Air Force Recruiting Service Procurement Management Information System (PROMIS). PJM is a sophisticated algorithm that computes an applicant's best job options for as much as 7 months in advance by comparing his interest and abilities with those of his contemporaries and Air Force needs. The primary output of the system is an ordered list of job opportunities from which a person will choose. The list is ordered and limited so as to maximize Air Force personnel effectiveness. Recruiters indicate that the system, in matching the applicant's abilities, interests, and Air Force needs, virtually guarantees placing "the right person in the right job."

Research scientists from the Occupation and Manpower Research Division modify the algorithm for the Person-Job-Match System (PJM). PJM is an operational, computer-based, job assignment system developed by the Laboratory to optimally match new recruits with Air Force job requirements.



## PERSONNEL RESEARCH DIVISION

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As part of Research on Air Force Female Pilot Program, pilot applicant undergoes test on complex task coordinating abilities on an aircrew psychomotor testing device. The study was conducted by scientists from the Personnel Research Division.

A major portion of the Air Force budget is personnel cost. A major contributor to personnel costs is attrition of first-term personnel. Of every 100 non-prior service accessions, 15 are lost in training, with an additional 10 to 12 lost during their tour. Over half of those completing the first tour and eligible to reenlist fail to do so. The Personnel Research Division is doing research to develop methods and devices which will reduce untimely attrition and increase career motivation of Air Force personnel.

The Personnel Research Division develops improved methodologies for the selection, classification, and assignment of Air Force military personnel. The Division conducts research into the nature of individual differences, methods of measuring those differences, and means for their

systematic application in Air Force selection and assignment programs. The Division meets research and development requirements for the Armed Services Vocational Aptitude Battery to support Air Force single managership of this battery.

In order to improve selection and classification techniques, the Division is conducting studies of personnel utilization, job satisfaction, and career development. Among its research efforts are projects to determine the impact of assigned work on job satisfaction, retention, and the development of career intent. Efforts toward the development of measures of job performance to be used as criteria for selection and classification measures have led to the development of a performance appraisal system for Air Force civilian personnel.



## TECHNICAL TRAINING DIVISION

The Air Force inventory includes a vast array of complex and highly technical weapons and delivery systems. The sophistication of these systems, the need to maintain a high level of readiness and the inherent personnel turnover of a voluntary military system demand a high level of technical training and skill upgrading activity. To meet the need for continual training, the Air Force has evolved complementary systems of resident technical schools and formal on-the-job training (OJT).

The Technical Training Division is responsible for research in the areas of technical training, particularly for developing, demonstrating, and evaluating improved methods, media, and systems for technical training. The Division is doing research to determine what training is best accomplished in resident and what training should be done on the job.

The Technical Training Division has developed an individualized, computer-based, multi-media, Advanced Instructional System (AIS). The system was designed to provide technical training and

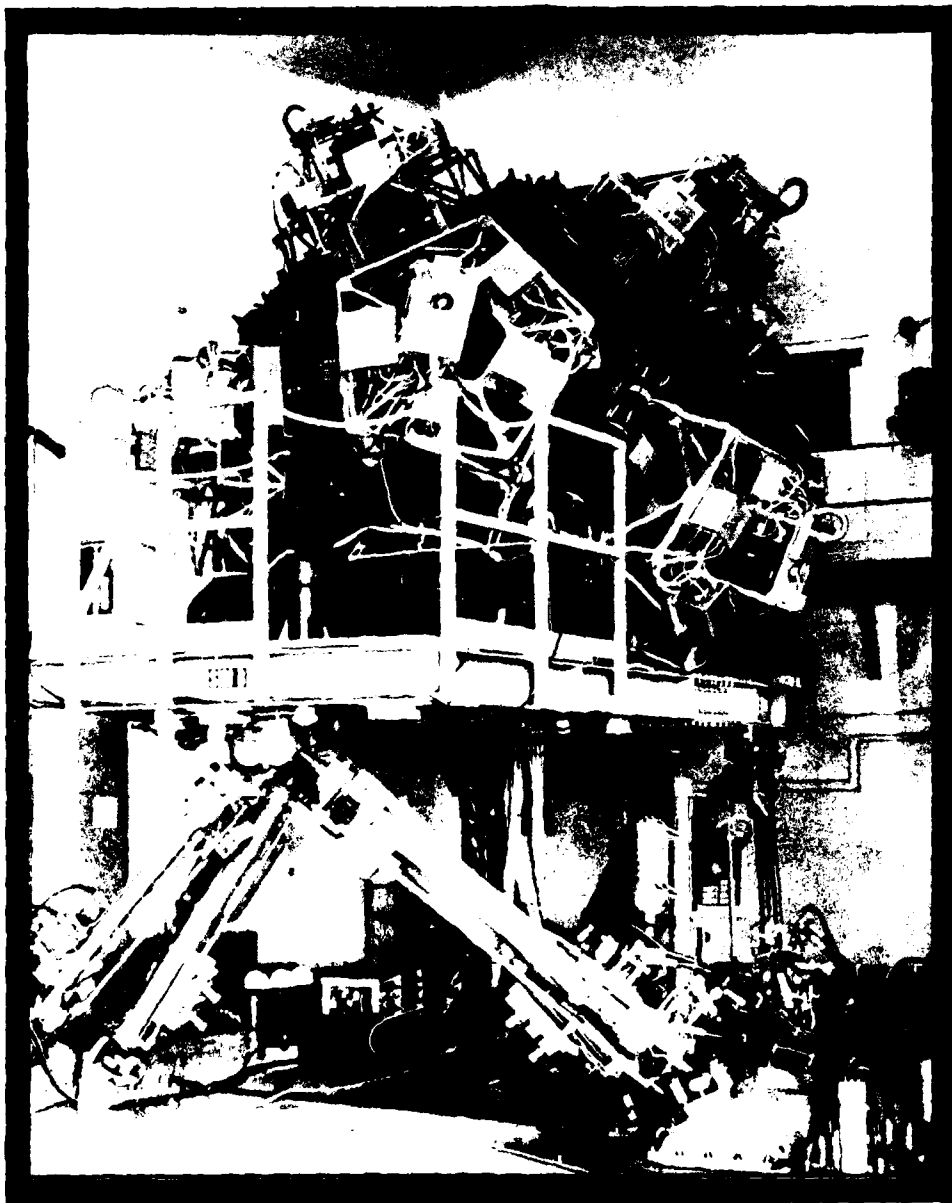
course management for up to 2,100 students per day in four selected courses at the ATC Lowry Technical Training Center (LTTC) and to provide a research facility for a continuing program on development and test of instructional technology. System development and integrated system test were completed in October 1977, and the instructional portions of AIS for the four technical training courses were transitioned to LTTC at that time. The system demonstrated significant student time saving when compared to conventional methods of training while maintaining and improving quality of graduates.

Continued research in the areas of computer-assisted instruction, computer-managed instruction, the development of simulators for maintenance training, and the development and evaluation of instructional and management techniques to improve the cost effectiveness of the Air Force OJT system are the major research and development (R&D) Thrust of the Division.



AFHRL Project Scientist, working with an Air Training Command Instructor, tests the F111D (6883) Flight Converter Station.

# TECHNICAL ACHIEVEMENTS



## FLYING TRAINING TECHNOLOGY

**Title: Advanced Training Features and Concepts in Flying Training Simulation**

*Description:* In the first of a series of studies to be conducted, pilots acquired a manual weapons delivery task (the 30-degree dive bomb task) under an approach where the last link in the response chain was acquired first. Performances under this approach, called backward chaining, were compared to those of pilots who acquired the same task under the more traditional whole task method. When training time for the two methods was equated, the accuracy for pilots trained under the backward chaining method was significantly better than that for pilots trained under the whole task method. Of additional interest is that in the time required for seven of 10 pilots in the backward chaining group to reach criterion, only three of 10 pilots in the entire task group had done so. A second, closely related, study sought to further extend the training efficiencies developed in the earlier study. In this second study, the simulator arranged for the presentation of immediate visual feedback as to the bomb's impact as well as to automatically reset the simulator to the exact conditions present at the time the bomb was released. Through the use of immediate feedback and "freeze," a significant reduction was obtained in the number of training trials needed to acquire proficiency in the critical final leg portion of the task. Research is continuing to explore ways of improving the instructional effectiveness of these and other automated instructional support features. A third study in the series addressed the effectiveness of the simulator's record/playback feature as compared to the use of the same amount of time for additional student practice. The task was the first two leaves of a cloverleaf maneuver. Students were undergraduate pilot training (UPT) students at a pre-solo phase of training. The results showed that by the end of training, the performance of students receiving the playbacks was no better than that of students who were simply given the same amount of time for additional practice. In a study soon to be conducted with the Naval Training Equipment Center on the Visual Technology Research Simulator, the use of augmented visual feedback and freeze will be

evaluated within the context of a carrier landing task. The task is similar to the weapons delivery task as well as to the overhead traffic pattern acquired early in training by the Air Force students. The focus of work in the coming year will turn to the development and application of advanced training features and concepts for tactical flight simulation. Studies are planned which will address specifically the utilization of the A-10 in a simulated high threat environment.

*Impact:* These studies have provided a clear demonstration of the ways in which advanced instructional support features of a flight simulator can be applied in actual operational training situations. The backward chaining approach to the weapons delivery task has been favorably received by simulator users in the Tactical Air Command (TAC) and is impacting simulator training being conducted for TAC on the F-16 configuration of the Advanced Simulator for Pilot Training (ASPT).

*Benefits:* The results of studies such as these are helpful to those who utilize flight simulators, and point out which instructional support features offer promise of greater training efficiencies and which may not. Together, the results of such studies permit the eventual development of more effective automated approaches to flying training instruction.

**Title: Aircrew Performance Measurement for Air Combat Maneuvering Training**

*Description:* Exploratory studies were initiated to define and describe candidate concepts for measuring aircrew performance in simulators that provide Air Combat Maneuvering (ACM) training. Two contract efforts were completed and will be used in subsequent development of aircrew Performance Measurement (PM) systems. One effort provided a validation study of the Good Stick Index (GSI). The GSI is a measure of the training Tactical Air Command and Aerospace Defense Command pilots receive during contract ACM training programs at the Vought Corporation Simulation Facility. The other effort was conducted to develop

an approach to PM for ACM and to derive preliminary measures for the assessment of one-on-one free engagements in the Simulator for Air-to-Air Combat (SAAC) located at Luke AFB. Also, an in-house effort was initiated to evaluate PM methods used by Navy and Air Force test units at ACM ranges.

*Impact:* The results of these studies will be used in the on-going development of performance measures for the full range of flying training programs. Although the total concept of PM and the resultant training effectiveness are still in early stages of development, the completed studies have substantially increased the understanding of viable PM methods.

*Benefits:* Development of PM techniques that can be used in ACM simulators and by aircraft in live engagements over ACM range facilities will provide significant indication of transfer of training and training accountability.

#### **Title: Attention and Task Complexity as Indicated by Physiological Indices**

*Description:* The objective of this research was to develop physiological measures of pilot attention and workload. In later studies, these measures will be used in conjunction with behavioral measures of pilot attention and task difficulty in order to optimally structure flight simulation training programs and equipment. One initial objective was to establish laboratory procedures for handling the large quantities of data involved in psychophysiological research and to insure that all components of the computer laboratory were functioning properly. The variables of heart rate, skin conductance, cortical evoked potentials, and eye movement have not been investigated simultaneously in previous research, and a second major objective of this study was to investigate the interrelationships of these variables with each other and with performance on two common information processing tasks. Two common behavioral information processing tasks were used to study four physiological variables: heart rate, skin conductance, eye movement, and cortical evoked response. Heart rate and skin conductance were studied as indicators of autonomic arousal. The cortical evoked potentials were related to attentional state and the complexity of stimuli being processed. The eye movement data were used in the interpretation of the cortical evoked potentials.

*Impact/Utilization:* The measures of arousal (heart rate and skin conductance) reflected, in a gross sense, the degree of subject involvement in the task, and both early and late components of the cortical evoked response varied reliably with task difficulty and performance. This was generally true in all four experiments, but the results were more clear in some experiments than in others. It was concluded that the psychophysiological assessments of attention and arousal present a potentially powerful methodology for assessing human performance.

*Benefits:* Assessment of human performance has become more difficult as the complexity of man-machine systems has increased. The point has been reached where behavioral research must step beyond the limits imposed by quantifying behavior in terms of motor responses only. Psychophysiological assessment of the internal state of the operator shows promise of providing the tools to take this step. By combining behavioral and psychophysiological assessments, a more comprehensive profile of human performance should emerge. This should permit a greater understanding of the conditions under which performance deteriorates and should point to techniques that will maximize performance.

#### **Title: Cost-Effectiveness Methodology for Aircrew Training Devices**

*Description:* A computer methodology and the associated software were developed for evaluating the cost and training effectiveness of devices used in aircrew training programs. The primary purpose of the methodology is to identify the most cost-effective mix of training devices (including aircraft, simulators, and part-task trainers) for aircrew training for a given weapon system. The methodology is applicable to training programs at all levels for both existing and future weapon systems. The computer model requires input data on training requirements and device training capabilities. Some of this information is not routinely available, and some (e.g., training capability) must often be estimated in the absence of hard data. The model uses device requirements and capabilities data to identify all mixes of devices that can satisfy training requirements; it then uses device acquisition and operating costs to select the most cost-effective mixes of devices for accomplishing the training and to compute the life-cycle costs of these sets of devices.

**Impact:** The model is designed to combine cost data with training effectiveness data so as to permit decisions which require trade-offs between the two. The model is (a) consistent over a broad range of training situations, (b) flexible in accommodating differences of data inputs and outputs, (c) sufficiently comprehensive to permit inclusion of a variety of significant factors, and (d) simple to use.

**Benefits:** This model is applicable to the analysis of both existing and future aircrew training systems. It also contributes to the analysis of many aspects of training effectiveness to include determination of (a) device cost-effectiveness, (b) the optimum mix of several devices, and (c) the optimum deployment and utilization strategies for training devices.

**Title: Evaluation of Alternative Heads-Up Display Symbolologies for the A-10 Aircraft**

**Description:** In conjunction with the installation of an inertial navigation system (INS) in the A-10 aircraft, an expansion in symbology was proposed by the Aeronautical Systems Division, A-10 Systems Program Office (ASD/A-10 SPO) for the A-10 Heads-Up Display (HUD). The new symbology would reflect the automated navigational capability of the INS. The existing HUD displays airspeed (AS), Altitude (ALT), roll bar, mil setting (MIL), gun cross (GC), pitch, pipper, and reticle. The new HUD would add magnetic heading (H), vertical velocity indicator (VVI), dive angle (DA), total velocity vector (TVV), destination index (DI), time to destination (T), and distance to destination (D). The roll bar would be replaced with a flightpath ladder (FPL), and digital pitch would be replaced with digital dive angle in the new HUD. The HUD operates in two modes—flight mode (FM) for navigation to the target area and weapons mode (WM) for weapons delivery. The GC and reticle are not present in the FM, and VVI is not present in the WM. The following three issues arose concerning display format for this additional symbology. (a) Should the standard sliding scales (tapes) for airspeed and altitude be replaced with digital readout (odometers) in order to provide a less cluttered HUD? (b) Should the flightpath ladder drift with the total velocity vector in order to portray yaw and to reduce the requirement for shifting eye fixation at critical moments, or should it remain stable along the central axis of the HUD? That is, should the FPL drift in order that the TVV and FPL are always aligned with the flight path of the aircraft? (c) What declutter options should be employed in flight

mode and weapons mode? ASD/A-10 SPO specified the declutter options to be tested. Flight mode declutter A (FMDA) removed T, D, H, and VVI. Flight mode declutter B (FMDB) removed only H and VVI. Weapons mode declutter A (WMDA) removed FPL only. Weapons mode declutter B removed FPL, T, and D. The FPL is replaced with a roll bar when decluttered. A simulator study was designed to provide preliminary data addressing these issues which would be useful in planning flight tests for a more comprehensive resolution of alternative displays.

**Impact:** Alternative configurations of HUD symbology were found to significantly affect performance in navigation and weapons delivery tasks. Various needed improvements in such configurations were identified.

**Benefits:** The results of this research were utilized to increase the effectiveness of A-10 flight tests of the new INS and HUD by reducing the number of sorties required for evaluation. In addition, this research provided a broader base of pilot assessment of proposed symbology than would be available by flight tests alone.

**Title: Evaluation of the Transfer of Training of the Boom Operator Part-Task Trainer**

**Description:** The purpose of this research was to assess the training effectiveness of the Boom Operator Part-Task Trainer (BOPTT), an air refueling simulator. Three specific objectives were addressed: (a) to determine the transfer of training from the BOPTT to the KC-135 aircraft for the Combat Crew Training School (CCTS) boom operator student, (b) to evaluate the effectiveness of the BOPTT in the Central Flight Instructor Course (CFIC) where it serves as the sole training device, and (c) to estimate the cost-avoidance potential of the BOPTT in the CCTS program.

**Utilization:** CCTS students trained in the BOPTT required significantly fewer air refueling attempts (50 versus 71) to reach proficiency in the KC-135A air refueling skills than did students trained by the standard syllabus. In boom operations, procedures, and communications, all BOPTT-trained students were equal or superior to the students in the standard syllabus. Using the BOPTT as a surrogate for the KC-135A, instructor trainees who received all training sessions in the BOPTT demonstrated

proficiency equal to that of instructor trainees who received all training in the KC-135A aircraft. This 1:1 training transfer ratio afforded by the direct substitution of BOPTT training for aircraft training in training experienced boom operators is a striking confirmation of device effectiveness.

*Benefits:* The BOPTT was shown to be an efficient medium for training all aspects of boom operator skills. The data indicate that the transfer of training value from the BOPTT to the aircraft was 67% in the CCTS program and 100% in the CFIC program. The findings of this study will result in substantial changes in the CCTS and CFIC training programs and in greatly reduced training costs.

**Title: E-3A Aircraft (Sentinel) Flight Simulator Follow-On Operational Test and Evaluation**

*Description:* AFHRL was asked to assist in the E-3A Aircraft Flight Simulator Follow-On Operational Test and Evaluation (FOT&E) relative to training capabilities, psychological fidelity, and human factors engineering. The tasks were to assess the psychological fidelity of the flight simulator (FS), assess the capability of the FS to train the required tasks, and assess the human factors engineering of the instructional features—specifically, the compatibility between the FS instructional features (Instructors Console and Radio Aids Console) and the operator's functions.

*Impact:* The construction of the FS was physically dictated by the aircraft cockpit. As such, standards dictated by various specifications were in many cases exempt. Further, the nature of the visual system restricted the trainability of a number of tasks. The compatibility between the FS instructional features and the consoles and the operator's functions were evaluated, and those features which would enhance the training capability of the FS were identified for improvement. Recommendations were made for training effectiveness and operational effectiveness.

*Benefits:* Incorporation of recommended changes should significantly aid in further development and refinement of an effective E-3A mission crew training program.

**Title: F-15A Aircraft (Eagle) Flight Simulator Follow-On Operational Test and Evaluation**

*Description:* AFHRL was asked to assist in the operational evaluation of the F-15A aircraft flight simulator (FS) in the operations, training, and logistics area. The effort focused on evaluating the fidelity of the FS, validating computer scoring algorithms, and testing the effectiveness of instructional methodologies used in part-mission training. In addition, potential areas for enhancing existing training programs were identified. The Instructor Operator Station was evaluated, the training effectiveness of the FS was tested, and the life cycle cost of the F-15 simulator was determined.

*Impact:* By allowing direct comparison of the computer scoring system with instructor pilot (IP) evaluation, discrepancies in the computer scoring system were identified and recommendations for improvement made. The Human Factors Engineering evaluation of the instructor/operator station (IOS) highlighted several discrepancies, and appropriate recommendations for change were made. The number of errors made by the IPs on the IOS was the subject of a separate study of training effectiveness which led to the generation of inputs for use in future IOS design and training. The life-cycle cost study provided the system with cost figures for each program element through FY91.

*Benefits:* The benefits accrued from the findings and recommendations have resulted in improved training capabilities with reduced inefficiencies and inaccuracies on the IOS. Overall, the utility of the FS has been enhanced as a functional device for operational training.

**Title: FY79 Simulator for Air-to-Air Combat (SAAC) System Refinement and Enhancements**

*Description:* In the continuing process of refining the Simulator for Air-to-Air Combat (SAAC) through management of the maintenance contract by the Air Force Human Resources Laboratory, significant enhancements affecting operational training, training research, and maintainability were incorporated. The Adaptive Maneuvering Logic

(AML) program, refined to provide an effective, computer-driven adversary in both 1 vs. 1 and 2 vs. 1 modes, has been expanded to include a canned, preprogrammed target aircraft flightpath program usable for both operational training and training research. A fourth central processing unit (CPU) plus peripherals has been intergrated into the operating system along with new linkage to the visual system. Additionally, the cockpit instrument panel of one cockpit was updated to an F-4E configuration with the inclusion of a new multiple weapons select panel. Finally, a video recorder has been added to the remote Air Combat Engagement Display (ACED) as a further instructional aid.

**Impact:** The improved AML effectively doubles the training utility of the simulator by providing instructional capabilities for a student in each cockpit by a single instructor pilot located at the instructor operator console. The preprogrammed target aircraft, a new research capability, permits a comparative evaluation of performance of a number of pilots engaged with an opponent aircraft operating in constant, predetermined maneuvers. The additional CPU and visual linkage have enhanced the availability of the simulator for training, expanded its use for off-line program development and software refinements without interference with ongoing training programs, and established a stand-alone visual maintenance capability improving maintainability of the system. Integration of the multiple weapons select panel, replicating that of the F-4E, was made to enforce procedural training with actual aircraft switchology. The remote video recorder has proven to be an effective debriefing tool which provides a near real-time replay capability for review of engagements by aircrews immediately upon egressing from training sessions.

**Benefits:** The benefits accrued from incorporating these changes have resulted in improved maintainability of the system, enhanced its availability for training, reduced the possibility of providing negative training from incorrect switchology, and enhanced the utility of the device for performing flying training research.

**Title: Psychophysiological Effects of Training in a Full Vision Simulator**

**Description:** The purpose of this study was to evaluate the psychophysiological dysfunctional responses which occur in the Simulator for Air-to-Air Combat (SAAC) and to explore possible

methods to reduce these reactions. In response to a series of reports that pilot trainees experienced dizziness, fatigue, nausea and vivid visual flashbacks of experiences after intensive training in the SAAC, the Tactical Air Command (TAC) requested that AFHRL study this problem. An interview technique was employed to gain information directly from the pilots. The group of pilots studied (N=48) were all fully-qualified F-4 pilots who were being trained in the TAC Air Combat Engagement Simulator (TAC ACES) course at Luke AFB. The pilots were interviewed on the fourth day of the 5-day course, after having had extensive experience in the simulator. The results of the interview revealed that only 12.5% of the pilots were symptom-free throughout their period of training in the SAAC. The most frequently reported symptom was nausea, which occurred in varying degrees in 79.20% of the pilots. Other symptoms, in order of frequency were balance problems, 60.42% ; profuse sweating, 54.20% ; sense of spinning, 54.12% ; sense of abnormal maneuvers, 25.00% ; and other (headache etc.), 22.92% . The occurrence of symptoms was thus shown in a large proportion of the pilot group studied. One of the main contributing factors for this high proportion of nausea cases was considered to be the frequent use of the freeze mode on the simulator particularly during high risk task loading in air-to-air combat.

**Impact:** The study of psychophysiological dysfunctional responses in the SAAC has led to several modifications of the instructional procedures aimed at reducing these dysfunctional responses. Further studies are planned to include the nature of the dysfunctional responses so as to make further refinements in procedures.

**Benefits:** The benefit of this first study on psychophysiological disturbances is that it has produced a more thorough assessment of the problem and has suggested a line of research to study the problem.

**Title: Simulated A-10 Combat Environment**

**Description:** The purpose of this study was to test the feasibility of using the Advanced Simulator for Pilot Training (ASPT) in training pilots for combat in a simulated hostile environment. It has been suggested that in the future, complex flight simulators will not be limited simply to procedures and instrument training, but will serve the much

broader need of training combat-ready pilots in the complex task of tactics development. In this study, seven A-10 combat-ready pilots were evaluated on offensive and defensive skills while flying through a simulated hostile environment. The environment included three surface-to-air missile (SAM) sites and four anti-aircraft-artillery (AAA) sites. The offensive task was to destroy a tank located at random positions along a roadway. Each pilot was briefed on the environment and instructed to fly into the combat area, destroy the tank, and safely egress the area. Ten missions were flown in the morning and 10 in the afternoon by each pilot. The results showed that there was a clear and substantial learning curve for both offensive and defensive performance in which there was marked improvement in performance with repeated trials.

**Impact:** This study, being the first thorough, real-time simulation of a combat scenario, has served in the development of techniques for tactics development. Since the acquisition of skills has been shown to develop so clearly, the study has given impetus to continued development in the use of the ASPT for training combat skills. If this sort of training is extended to more complex and elaborate scenarios, cost benefits could be very substantial.



Computer-Generated Image Simulating an attack on a tank.

**Benefits:** The benefit of this preliminary study is that it serves to establish a beginning data base of simulation for future tactical development studies.

#### **Title: Tanker/Transport Bomber Training Requirement**

**Description:** A 1-year contract effort in support of anticipated development by the Air Training Command (ATC) of a dual-track Specialized Undergraduate Pilot Training System (SUPTS) accomplished the following tasks: (a) identification of lead-in training for Military Airlift Command (MAC) and Strategic Air Command (SAC) aircraft to which undergraduate pilot training (UPT) graduates are currently assignable; (b) identification of the subset of training requirements to both SAC and MAC; (c) development of ways of estimating the training benefits to be derived by MAC and SAC from tanker/transport/bomber (TTB) lead-in training on common tasks; (d) development of a method for determining the generalizability of any subset of TTB tasks to the entire domain of TTB training tasks; and (e) development of a candidate TTB performance measurement system based upon the model of the C-5A Performance Measurement System which is not undergoing development. The contract effort is now complete. The results of this effort will serve as a basis for subsequent ATC development of a candidate TTB training syllabus.

**Impact:** This work extends previous efforts on the part of ATC, as well as of MAC and SAC, in the identification of those tasks which would be trained in the TTB phase of a SUPTS.

**Benefits:** This work provides a logically and empirically constructed data base upon which to build a TTB training syllabus. The approach developed a method which addressed the extent to which specific tasks can be expected to generalize (transfer) to other tasks not covered by the training program. This information can be used to answer questions concerning cross-training between TTB aircraft, as well as design questions regarding alternative configurations for a TTB trainer aircraft and supporting simulator. A candidate performance measurement system incorporating work under progress with the C-5A provides relevant information for assessment by ATC of the TTB aircrew performance.

## **FORCE STRUCTURE AND UTILIZATION**

#### **Title: Additional Impact Analysis for the 1977 Reevaluation of the Weighted Airman Promotion System (WAPS)**

**Description:** In response to a Request for Personnel Research (RPR 76-33), "Revalidation of

the Factors which comprise the E-5/E-7 Weighted Airman Promotion System (WAPS)," a multipart policy-capturing study was initiated in March 1977. During Fiscal Year 1979, research activities focused upon the following objectives: (a) to analyze the impact on minorities and women when



incrementally increasing the weight on the Specialty Knowledge Test (SKT) factor, (b) to analyze the impact on minorities and women when incrementally increasing both the weight on the SKT factor and the weight on the Promotion Fitness Examination (PFE) factor simultaneously, and (c) for those Air Force Specialty Codes which require no SKT, to analyze the impact on minorities, women, and junior airmen when incrementally increasing the weight on the PFE factor. All planned work in support of RPR 76-33 has been completed.

**Impact/Utilization:** The WAPS was developed by AFHRL in 1968 to provide a computerized promotion system that was both equitable and visible to airmen. Since the implementation of WAPS in 1970, airmen in grades E-4 through E-7 have been selected for promotion based on their mathematically weighted composite promotion scores consisting of six promotion selection factors. The weights and factors have been periodically reevaluated by AFHRL and the research outcomes used to recommend any improvements to the existing WAPS. The results of the analysis will assure Air Force managers that no proposed modifications to WAPS will have an adverse effect upon women or minorities.

**Benefits:** The results of the impact analysis reported here contribute to the overall improvement and effectiveness of the current WAPS. The benefits of WAPS are, in turn, more objectivity in promotion selections, better understanding and acceptance of the system by airmen, higher morale, increased efficiency, and increased quality of selectees.

**Title: Assessment of Safety Training Priorities for Air Force Jobs**

**Description:** From field inspections and accident data reviews, the Air Force Inspection and Safety Center provides input to technical training course designers to insure that job safety-related factors are covered in sufficient depth during training. This research project is designed to study the feasibility of developing and implementing a standardized methodology for prioritizing job tasks along such dimensions as hazard, frequency of accidents, and other safety-related aspects, which could then be used to more accurately determine the safety training for specific jobs.

**Impact/Utilization:** Information from a standardized methodology assessing safety training needs would be used in concert with other occupational analyses data by technical training course designers and managers to insure the maximal productive utilization of training time. Application of this methodology across tasks and jobs could also be used by Air Force management in projecting time loss by accident.

**Benefits:** Implementation of this methodology should result in improved job safety, avoidance of personal injuries, reduction of equipment time loss, and reduction in material loss due to on-the-job accidents.

**Title: Design of a National Skills Market Model for Air Force Enlisted Personnel**

**Description:** Detailed specifications were developed in this study to describe feasible options available for designing and implementing a National Skills Market Model—an empirically based forecasting model of economic activity in the industrial and occupational labor markets in which the Air Force competes for its labor. Essentially, the model formulated in this study consists of three basic analytic components which, in combination, produce detailed forecasts of national labor market conditions, and generate projections of the total accession and retention of Air Force enlisted personnel. The basic analytic components include a non-military labor module, a population projection module, and an accession/retention rate forecasting module. Each of these components is then subdivided into one or more analytic elements which address distinct aspects of the general issue examined in the analytic component. Results of this effort are documented in AFHRL-TR-79-32, *Design of a National Skills Market Model for Air Force Enlisted Personnel*, published in September 1979.

**Impact/Utilization:** A significant feature of the proposed modular structure of this model is that it permits the initial development and subsequent utilization of each analytic element of the model to be performed relatively independently, without compromising the analytic properties of the remaining elements. Results of this research will be used in the subsequent development of an Air Force

**National Skills Market Model.** Its basic purpose will be to provide Air Force policy makers and decision-makers with the capability to determine the impact on accessions and retentions resulting from the interaction of Air Force policies and economic, demographic and environmental conditions.

**Benefits:** In addition to projecting accession and retention rates, the model will generate information about the national labor market useful to, and usable by, Air Force policy-makers and decision-makers in the performance of their assigned functional responsibilities.

**Title: Development and Validation of Measures to Assess the Correlates of Successful Performance in the 81XXX Career Field**

**Description:** The purposes of this research were to (a) select and/or develop screening methodologies to measure the personal, psychological, attitudinal, and motivational correlates of successful performance in the 81XXX career field, (b) field test and evaluate methodologies on a representative sample of 81XXX accessions, and (c) assess the effectiveness of the screening techniques and furnish recommendations for improving the quality of the security police force. Results are reported in AFHRL-TR-77-38, *Preliminary Development and Validation of a Screening Technique for Entry into the Security Police Career Field*; AFHRL-TR-77-79, *Screening for Entry into the Security Police Career Field*; and AFHRL-TR-79-16, *Correlates of Successful On-the-Job Performance in the Security Police (Air Force Specialty Code 81XXX) Career Field*. This research effort was initiated as a result of a Request for Personnel Research (RPR 74-14) from the Air Force Security Police Directorate.

**Impact/Utilization:** The 81XXX career field, which comprises about 35,000 persons (approximately 6% of the total enlisted force) has had an unacceptable number of first-term airmen who become noneffective and who subsequently are either retrained or separated from the Air Force. This is a substantial loss of money and manpower resources which might be minimized through a more refined selection and classification system. The results of this research effort form the basis for selecting those personnel who have the maximum likelihood of becoming successful security policemen. Due to the decrease in attrition in recent

months, this screening methodology is being held in abeyance at present. However, if an increase in attrition should occur, operational use of a selection composite developed from this research project would be considered.

**Benefits:** Costs associated with retraining and separation of personnel who are noneffective security policemen could be reduced by identifying those not likely to succeed in this career field. Additionally, there are intangible savings associated with having a security police force composed of maximally effective personnel to insure operational readiness.

**Title: Development of a Methodology to Assess Psychological Stress and its Impact in the Air Combat Environment**

**Description:** As a result of a request from the Tactical Air Command, a joint effort evolved between AFHRL and the USAF School of Aerospace Medicine to develop a methodology (a) to identify which aspects of a combat fighter mission produce the psychological experience of stress, (b) to assess the level of stress generated by various aspects of a fighter mission, and (c) to evaluate the impact of stress on performance in air combat.

A methodology was developed and a trial administration was conducted using subjects having extensive Southeast Asia combat experience. Based on the results of the trial administration, it would appear that the methodology is valid and capable of identifying empirical relationships between psychological stress and performance in air combat. As a follow-up to the trial study, data have been collected from 500 additional Southeast Asia combat experienced pilots. Analyses of these data are in progress with preliminary indications of significant differences associated with aircraft type and aircrew experience. The results are reported in AFHRL-TR-78-3, *Methodology to Assess Psychological Stress and its Impact in the Air Combat Environment*.

**Impact/Utilization:** Empirical evidence generated by this methodology should be of use to operational managers and strategists, within the training environment, and within the selection and classification system for rated personnel. Increased knowledge of the stress associated with fighter missions and of the stress management of fighter

pilots will allow more precision in estimating personnel requirements and in maximizing the effective utilization of combat aircrew resources. Additionally, in combination with other on-going research efforts, it is possible that a stress management factor might be introduced into the pilot screening program, either at the point of initial selection, or a differentiation into cockpit assignments. Finally a spin-off benefit is the generation of a data base relevant to the maximum number of fighter missions that a single pilot could effectively fly against heavily defended targets in a 2-week period. This information is important with regard to "sortie surge" maximums. Efforts are underway to extend the application of this methodology to a data base with combat experienced personnel and to establish a complementary data base from the simulated combat environment.

*Benefits:* The focus of this project was towards enhancing the selection, training, and management of combat aircrew resources, thereby increasing the operational readiness of the Air Force.

#### **Title: Development of an Organizational Assessment Package (OAP)**

*Description:* This research involved the development of an Organizational Assessment Package (OAP) for use by the Air Force Leadership and Management Development Center (LMDC) in identifying organizational problem areas. The OAP was developed on a contingency model of organizational effectiveness which considered organizational effectiveness to be a function of the manager, the situational environment, and the criteria of success. The results are reported in AFHRL-TR-78-93, *Organizational Survey Assessment Package for Air Force Organizations*, and AFHRL-TR-79-10, *Situational Factor Identification in Air Force Organizations*, and AFHRL-TR-79-16, *Organizational Assessment Indices of Effectiveness*.

*Impact/Utilization:* The OAP is used by LMDC travel team members as their prime instrument to guide their organizational intervention program. OAPs are administered to work groups at installations throughout the Air Force; work group effectiveness factor indices are generated for each work group; and problem areas are identified by LMDC consultants. The OAP became LMDC's operational instrument in September 1978.

*Benefits:* LMDC has reported that at least three other surveys that were to be developed by other agencies were cancelled and the OAP used instead. LMDC travel team members report that their problem identification function and overall efficiency have been vastly improved by using the OAP. A data base developed from data collected on the OAP has provided LMDC with normative data which provide a means of comparing different groups (for example, different bases or commands and different Air Force Specialty Codes) and a given group with an Air Force or command norm. The OAP provides a means of testing the effectiveness of various intervention strategies used by LMDC travel teams.

#### **Title: Evaluation of Aptitude Requirements of Air Force Jobs**

*Description:* In an all-volunteer recruiting environment, particularly with a decreasing manpower goal projected for the 1980's, it is critical to insure that minimal aptitude requirements not be overstated and that high level talent be allocated to jobs having the greatest difficulties. A methodology has been developed to assess the aptitude requirements of Air Force jobs based on the relationship between the relative aptitude requirements and the relative learning difficulty of job tasks. Using a benchmark task approach across specialties, this methodology has been applied to jobs in the Electronics, Mechanical, and General aptitude areas. Additionally, methods to assess the clerical aptitude requirements of Air Force jobs have been developed and are currently being evaluated.

*Impact/Utilization:* Results from this research regarding the realignment of aptitude requirements for approximately 100 Air Force jobs have already been provided to the Air Force Manpower and Personnel Center. Additional data from 70 more jobs will be available shortly. The findings of this project are also being implemented through the computerized job-offer system used by the Air Force Recruiting Service. A complete implementation package, including a comprehensive impact analysis, is currently being developed.

*Benefits:* There are three significant areas where cost avoidance should be achieved as a result of this research. Contingency plans for talent shortages will be available as a product of this effort. These plans will enable the Air Force to specifically plan for talent shortages in any specific specialty or across all

specialties. Another product will be a more defensible position for aptitude requirements in the case of court actions. The present system, which excludes many individuals from entering Air Force jobs based on a "cut-off aptitude score," has no objective data to support its use. This research will provide data on the learning load requirements for each job. Another product will be an improved match-up of Air Force talent and job requirements. Improving this match of talent with requirements can have effects on job attitude, retention, recruiting, and training.

**Title: Expansion of the Person-Job-Match (PJM) System**

*Description:* The Person-Job-Match system was first developed in 1976 for the purpose of classifying applicants into guaranteed Air Force jobs in the pre-enlistment environment. About 60% of all applications are currently classified by the PJM system. During FY 79, the PJM system was expanded to allow optimal classification of the remaining 40% of the recruits who are currently classified during Basic Military Training (BMT). The augmented version of the PJM system will classify the BMT trainees in a single weekly batch computer run. Some research has been completed on basic algorithms which use a recursive, self-correcting forecasting technique. The dynamic prediction models for enlisted skill payoffs were developed through a contract with Scientific Systems, Inc., together with an adaptive Kalman filter prediction algorithm which automatically changes its prediction parameters under changing conditions. The technical report, AFHRL-TR-79-29, *Pre-Enlistment Person-Job Match System*, gives a detailed presentation regarding Kalman Filtering and State Forecasting.

*Impact/Utilization:* The PJM System will be used by Air Training Command Air Force Recruiting Service and by the Air Force Manpower and Personnel Center to optimally classify trainees into Air Force jobs.

*Benefits:* The PJM System optimizes person-job assignments which, in turn, enhances job satisfaction, productivity, effectiveness and morale. The net result is a more effective work force and improved operational readiness. It is the basis of the Air Force Guaranteed Enlistment Program (GTEP) and greatly contributes to a favorable Air Force recruiting image.

**Title: Methods for Collecting and Analyzing Task Analysis Data**

*Description:* This effort was aimed at determining methods to define standardized task analysis methodology for use in the Air Force technical training environment. The contract was to identify methods for collecting and analyzing task analytic data that are simple to use, reliable, valid, and practical, for standardized application by Instructional Systems Development staffs at Air Training Command training centers. A task analysis handbook was developed outlining procedures that provide a degree of uniformity and quality control at various training centers and schools. To accomplish these objectives, a survey of current task analyses procedures was conducted, an experimental task analysis handbook was developed, and the handbook was field tested at selected training centers, revised, and finalized.

*Impact/Utilization:* The Task Analysis Handbook aids in the identification of objective information regarding essential skills and knowledges which the trainee must learn. It also holds the potential for increasing training efficiency while reducing training costs.

**Title: Productivity in Security Police Squadrons**

*Description:* The purpose of this research is to develop a methodology for measuring changes in the productivity of security police squadrons that result from squadron reorganization. Productivity measures will include both subjective criteria, such as supervisor ratings, and objective criteria developed in conjunction with job experts from the security police career field. Measures will be collected from bases matched for similarity in all respects except squadron organization. Data will be collected repeatedly from these bases in a time-one, time-two format. Policy capturing/specifying techniques will be used to identify the significant characteristics of effective security police squadrons. This research was initiated at the request of the Chief, Security Police in Europe.

*Impact/Utilization:* The results of this research will be used in decisions regarding the organizational structure of security police squadrons in Europe. Additionally, the technologies developed will be applicable for use in other AFSCs, as well as security police squadrons, throughout the Air Force.

**Benefits:** Results from this research will enhance the productivity of security police squadrons in Europe, provide a method for self-evaluation of unit effectiveness, and provide Air Force Inspector General personnel with improved methods for evaluating security police performance.

**Title: Recruiting Resource and Goal Allocation Modeling Research**

**Description:** This research effort has resulted in two different optimization models for use by the Air Force Recruiting Service. Both were developed by AFHRL in response to a formal Request for Personnel Research to examine the possibility of optimally allocating the resources under the control of Air Force Recruiting Service. One of the models was developed in-house with the cooperation of Dr. Charles Beswick of the University of South Carolina. This model is a modification of a sales force allocation algorithm which uses a non-linear market response function and a dynamic programming allocation routine to allocate recruiting effort. The other model, developed under contract to ORINCON Corporation of LaJolla, California, uses a Markov probability process to determine the optimal use of advertising funds and the allocation of recruiting quotas. Both of these models will be documented in future technical reports.

**Impact/Utilization:** Headquarters Air Force Recruiting Service has requested the development of these models and will be the ultimate user of the final operational version of the decision tools developed under this research effort.

**Benefits:** The use of decision tools in the difficult decision areas of resource utilization should result in better informed and therefore more effective use of the resources under the control of the Air Force Recruiting Service and enable this Service to achieve personnel input goals. Increased attention to optimal use of resources should greatly improve the decision-making process of Air Force Recruiting Service managers.

**Title: Research and Development of an Air Force Occupational Research Data Bank**

**Description:** The objective of this effort is to establish an Air Force Occupational Research Data Bank that will be concerned with the collection,

analysis, maintenance, ready retrieval, and reporting of a wide variety of current and historical information describing all airmen and officer occupations. Data elements from widely dispersed data bases will be integrated and related to each other in a systematic fashion. In addition to information about personnel resources, information about the correlates, antecedents, and consequences of selected occupational requirement variables will be included in the integrated data base.

**Impact/Utilization:** In addition to providing a quick response capability when information is requested from the many data bases at AFHRL, the Occupational Research Data Bank will provide new information about important policy issues that have not been properly addressed before, simply because the data from one subsystem (e.g., percent fill in an organization) have never been adequately related to data from another subsystem (e.g., accidents).

**Title: Retraining and Transferability of Skills**

**Description:** Air Force managers rely heavily on the capability to retrain enlistees from one occupational specialty to another in coping with the continuing problem of manning shortages and overages in career fields. A comprehensive evaluation of the operational retraining program and of the progress and performance of the 10,000 to 15,000 airmen who change specialties annually is underway. A recently completed study of performance in basic technical training suggests that retrainee achievements are comparable and in most schools superior to non-prior service enlistees (non-retrainees) with equivalent aptitudes. Additional analyses indicated that enlistees characterized by high military tenure, career airman status, and prior experience in a specialty with the same aptitude index are good candidates for retraining. These study results, as well as an evaluation of the viability of the current 10-point entry aptitude waiver policy, will soon be documented in AFHRL technical reports.

Other on-going and planned retraining research includes identification of the types of reassignment actions which are operating smoothly and those which are generating adjustment problems. Skill upgrading, career progression, and reenlistment rates are of interest. A major focus is transferability of skills and knowledges and the ease of movement between specialties.

**Impact/Utilization:** Current research will provide managers of the Airman Retraining Program and related programs, such as Palace Balance and CAREERS, with an empirical basis for evaluating and effecting policy decisions.

**Benefits:** Improved retrainee selection and assignment procedures can be expected to stimulate participation in the program, favorably impact reenlistment rates, and increase the productivity and satisfaction of airmen in second specialties. Assignments which optimize skills transfer will result in dollar savings through lowered attrition rates as well as reductions in training time required for retrained personnel to achieve proficiency in their new occupations.

**Title: Taxonomy and Assessment of Productivity Criteria**

**Description:** The purposes of this research are to (a) review current and past efforts to define/measure productivity, (b) classify those measures with respect to practicality, cost-effectiveness, and relevance to the Air Force, (c) systematize the major classes of

factors which have been shown to impact on productivity, and (d) develop a conceptual framework, based on empirical data, that can serve as a guide to future research and evaluation efforts. An extensive field survey of government and civilian agencies with responsibility for research, evaluation, and/or measurement of productivity is currently underway.

**Impact/Utilization:** The development of a classification scheme for productivity criteria across Air Force jobs will provide researchers and managers with a useful tool for designing and evaluating changes in organizational factors related to productivity. Additionally, the identification of and communication with various agencies involved with productivity research have fostered a positive interaction among those agencies.

**Benefits:** Results from this study will be used to plan and conduct a comprehensive approach to the study and measurement of productivity, increase the generalizability of results from studies on productivity, improve management of Air Force resources, and increase the readiness and effectiveness of Air Force personnel.

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## PERSONNEL AND TRAINING FACTORS IN ADVANCED SYSTEMS

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**Title: Demonstration of an Expert Estimate Technique to Predict Human Resources and Logistics Requirements**

**Description:** A demonstration of a technique for predicting human resources (HR) and logistics requirements associated with modern weapon systems (WS) has been performed. This technique is applicable during the very early stages of WS design, making it possible for logistics and HR factors to influence WS design.

**Impact/Utilization:** These research results have provided the final laboratory verification required of the technique. The Expert Estimate technique is now regarded as being a sufficiently tested design tool for the Air Force Acquisition Logistics Division (AFALD) use. AFALD's use of this technique will allow for a greater consideration of logistics and HR factors. Reduced HR and logistics costs throughout the WS life should result.

**Benefits:** It has been determined that the cost of ownership accounts for up to 80% of weapon system life cycle costs (C-130 data). It has been estimated that logistics and HR account for over half of the ownership costs. This technique allows logistics and HR factors to impact WS design so that logistics and HR costs should be significantly reduced.

**Title: Design Methodology for Human Resource and Cost Factors in Weapon System Acquisition**

**Description:** A methodology for using human resources and cost factors in weapon system design and planning studies was developed and demonstrated. The methodology, titled coordinated human resource technology (CHRT), integrates five technologies of maintenance manpower modeling, instructional system development (training), job guide development (technical data), system

ownership costing, and human resources in design trade-offs. The methodology operates from a single, consolidated data base (CDB). The methodology is applicable throughout weapon system acquisition and provides for (a) the early assessment of system design and support plan impact on human resources, logistics, and cost; and (b) the development of a mutually supportive and coordinated training program and technical manual set. The demonstration was accomplished using data from the conceptual, prototype, and projected minimum engineering development phases of the advanced medium short takeoff and landing (STOL) transport (AMST) aircraft program.

*Impact/Utilization:* The Department of Defense is requiring greater involvement of manpower, cost and logistics factors in weapon system design and development studies (DoD Directives 5000.1 and 5000.2). The methodology reported here will contribute to the accomplishment of this objective. A specific tryout and refinement of the methodology is planned for FY 80 to FY 82 in coordination with the Deputy for Avionics Control, Aeronautical Systems Division.

*Benefits:* A significant step has been taken toward achieving the DoD goal of comprehensive inclusion of manpower, cost and logistics factors in weapon system design and planning. The benefits will be in terms of reduced cost of ownership and increased operational readiness. Data from this study indicate that cost reductions of 10% to 20% and readiness increases of 5% to 10% can be expected. More definitive cost and readiness data will be determined in the follow-on FY 80 to 82 effort.

**Title: Develop Models of Maintenance Resources Interaction**

*Description:* The accurate forecasting of maintenance manpower requirements to support a weapon system is greatly influenced by the status of other major resources (e.g., spares and support equipment). The computer simulation, previously developed at AFHRL (the maintenance manpower model, utilizing the Logistics Composite Model (LCOM)) is used by the Air Force to determine the manpower requirements for weapon systems. Currently, LCOM requires that the other resources be held constant. LCOM would be more valuable if models of the maintenance resources interaction were developed. Determination of the LCOM sensitivity to the resources interaction for a weapon

system (F-15) under peacetime and wartime surge environments will provide the basis for the development of models of the interactions. The outcome will be models of the interaction between manpower, spares, and support equipment required to support weapon system operations and maintenance.

*Impact/Utilization:* The results of this study will be used to provide a means for more accurately forecasting manpower along with the requirements for spares and support equipment. The results also have the potential to provide the Air Force with a means for determining readiness. The users of the end products will be all Air Force LCOM users, working with both developing and operational weapon systems.

*Benefits:* The models of Maintenance Resources Interaction is of use for both developing and operational aircraft and is an invaluable tool for determining resources and for trade-off decisions concerning manpower, spares, and support equipment. In addition, this methodology provides the Air Force with a means for dealing with readiness issues.

**Title: Handbook for Selection of Format Options for Procurement of Technical Data**

*Description:* Significant progress has been made in recent years to improve Air Force technical data for maintenance. Application of job guide manuals, logic tree troubleshooting aids, functionally oriented maintenance manuals, and other types of improved technical data have significant potential for improving Air Force maintenance. However, implementation of these data is handicapped by the fact that many technical data managers are not sufficiently familiar with the various options and the applications for which each type of data are appropriate. Available information on the various types of data is widely scattered in technical reports and other documentation which is not readily available. A handbook describing the types of improved technical data that are available and providing guidance for the selection of technical data options for selected applications will be very helpful in overcoming this problem. The handbook developed under contract contains information about what technical order formats are available, how to determine which format to select, and how to procure and manage the development of the technical orders. Guidelines are also included for

implementation of the technical orders in an operational environment.

**Utilization:** The handbook is expected to become the basic source of information for technical order managers in the system program offices in the Air Force Systems Command, the Air Force Logistics Command, and the major operational commands. When available to technical order managers, the handbook should have a favorable impact on the technical order procurement process.

**Benefits:** The information contained in the handbook will help the technical order managers do a better job of procuring better technical orders. The procurement process will become more efficient, the technical orders will be more appropriate for the intended user, and the maintenance accomplished with the technical orders will be more efficient due to better data.

**Title: Life Cycle Cost Estimation of Simulated versus Actual Equipment Maintenance Training for the F-16 Avionics Intermediate Shop**

**Description:** At the request of the F-16 System Program Office (SPO), AFHRL performed an analysis and comparison of the life cycle costs of F-16 avionics intermediate level training when conducted on simulated versus actual aircraft and maintenance equipment. This effort was conducted in two phases. Phase I was a preliminary Life Cycle Cost (LCC) analysis which indicated that simulated equipment would save approximately 50% over actual aircraft equipment when used for training. Based on these findings, Phase II was accomplished to provide a more detailed analysis of the cost of the two training device alternatives. This analysis concluded that there can be a cost savings in training if simulated equipment is used in lieu of actual equipment as a training device. LCC of a simulated device was estimated to be 58.6% of that of actual equipment life cycle costs. No study was made regarding the actual training effectiveness of either type of device. Consequently, such evaluation is necessary prior to any final statement regarding the relative actual cost of the two types of equipment.

**Impact/Utilization:** The results of this effort have been reported to the F-16 SPO. This methodology can be used to help determine the specific factors and costs involved in the methodology developed. The methodology that has been developed also provides a

critical cost estimation technique that can be used to help make procurement decisions regarding maintenance training devices.

**Title: Personnel Availability Model**

**Description:** The Personnel Availability Model (PAM) is a computerized user-interactive model, personnel data bank, and application methodology for estimating the future availability of Air Force maintenance personnel on the basis of historical career transition activity as recorded in the Uniform Airman Record (UAR). The data bank contains a selection of data elements from the 1975/1976 UAR files for 95,000 airmen assigned to 13 Air Force Specialty Codes (AFSCs). The model represents career transition activity within USAF by a series of Markov processes, each depicting a subpopulation of airmen, with states defined by years of service and paygrade. State transition probabilities are calculated on the basis of actual transition activity data contained in the UAR. Subpopulations may either be defined on an a priori basis, such as by AFSC designation, or analytically established by applying a regression analysis technique called Logit Analysis. This technique identifies subpopulations consisting of personnel exhibiting similar career transition behavior and describes them in terms of individual attribute data contained in the UAR. It also provides a basis for assessing potential personnel policy impacts.

**Impact/Utilization:** The PAM, its data bank, and application methodology were to be applied in support of the Advanced Medium STOL Transport (AMST) program. Due to an interruption in that program, data were not available to identify the AMST maintenance personnel requirement. The PAM was applied, however, to produce sample estimates of the future availability of AFSCs presumed to be typical of AMST requirements. Their selection was predicated on their past/present assignment to similar systems.

**Benefits:** The PAM provides a capability to guide weapon system development in avoiding the establishment of support personnel requirements which are likely to be difficult or impossible to fulfill at a future point in time when the system becomes operational. It allows design and support planning to occur in fuller consideration of potential impacts on system ownership requirements.



**Title: Specification for the Accomplishment of Maintenance Task Identification and Analysis for Technical Order Development**

*Description:* Substantial research has indicated that a maintenance task identification and analysis is a vital part of any technical order development program. Known benefits include more thorough, detailed, and accurate data. However, no specification was available to specify a task identification and analysis for technical order development programs. The specification developed under contract incorporates the best of known task identification and analysis procedures. Recommended procedures include the positive identification of every task to be done on every component and the maintenance level where the work is to be accomplished. The determination of whether the task is to be included in the technical order, the specific test equipment required for every task, and the detailed task steps are also covered in the specification. Included also are user description requirements. This specifies that the intended user be identified in as much detail as possible. A handbook is also available to guide the contractor in producing the analysis.

*Utilization:* The specification and handbook are expected to become contractual requirements for future technical order programs. The guidance contained in both documents will be used by the contractor to accomplish the analysis and by the Air Force manager in the procuring agency to oversee the program.

*Benefits:* The availability and use of the specification and handbook will result in higher quality technical orders being procured. The development of a task identification and analysis will result in technical orders that are more complete and have fewer errors and that more nearly meet the informational needs of the users. Better technical orders should permit improved maintenance with fewer errors, thus resulting in more efficient and less costly maintenance.

**Title: Specification for the Development of Logic Tree Troubleshooting Aids**

*Description:* Previous research accomplished at AFHRL indicated that logic tree troubleshooting aids (LTTAs) were very effective in assisting the technician in isolating failed components. Although the logic tree format has been around for several

years, no specification was available to guide the development process. In addition, the LTTAs used by AFHRL in the experiment contained additional information to make the aids more usable by less experienced technicians. This additional information, called enrichment, was new to the logic tree concept. A specification for the development of LTTAs has been developed by AFHRL under contract. This specification provides total guidance to the contractor on how to develop the troubleshooting action trees. The specification provides guidance on failure mode analysis, on format, and on enrichment possibilities.

*Utilization:* The specification will be used by technical order managers in the System Program Offices (SPOs) as a contractual document when the logic tree form of troubleshooting aids is required. When identified in the contractual statement of work, the specification will be used by the contractor to develop the aids and by the Air Force manager to manage the development of the logic trees.

*Benefits:* The availability of the specification will permit quality logic tree troubleshooting aids to be developed. When properly utilized, logic trees can reduce the number of spare parts used, decrease the number of mistakes made, and can permit less experienced technicians to perform difficult troubleshooting tasks. Logic trees thus have the potential of improving maintenance performance while reducing maintenance costs.

**Title: Weapon System Design and Need for Human Resources Data**

*Description:* The Air Force Weapon System (WS) design process was analyzed and outlined in order to identify the WS designer's needs for human resources (HR) and logistics data. One hundred sixty-four interviews were accomplished with WS designers from nine aerospace and engine manufacturing companies. The need for HR and logistics data to support the many tradeoff studies conducted by project engineers, logisticians, and reliability and maintainability people was identified. Also, existing Air Force data systems were outlined. Next, the WS designer's needs for HR and logistics data were matched against the existing Air Force data systems in order to identify any deficiencies in the data systems. Finally, the detailed requirements for a logistics and HR data base, termed Unified Data Base (UDB), were outlined.

**Impact/Utilization:** The documentation resulting from this effort will provide WS designers with a quick reference as to the available HR and logistics data in the numerous Air Force data systems. Also, the most commonly investigated data parameters and the Air Force data systems which list their values are indicated. Finally, the UDB outlined verified the feasibility of developing a UDB under a follow-on exploratory development effort. To a significant degree, this study prompted the issuance of a Program Management directive for the development of a UDB by the Air Force Logistics Command

**Benefits:** The information contained in the documentation will help WS designers determine and prioritize the trade-off studies which they should perform, and thus help assure that HR and logistics factors are addressed during the WS design process as early as possible. Also, the follow-on UDB development effort will provide timely, available, consistent, accurate, and traceable HR and logistics data to WS designers, managers, logisticians, and human factors scientists within the aerospace companies, the Aeronautical Systems Division, Air Force Logistics Command and the Air Force Test and Evaluation Center.

## PERSONNEL SELECTION AND RETENTION

### Title: Perceptual-Motor Ability Measurement

**Description:** For over two decades, the Air Force has relied almost exclusively upon measures taken from traditional paper-and-pencil tests for the selection of both enlisted personnel and officers. This has been a valid and generally effective procedure, but one which has failed to utilize measures that numerous studies, in particular those conducted by the Army Air Force during World War II, have shown may make significant contributions to personnel selection. These measures, which are grouped under the term "perceptual-motor," typically require the use of some apparatus other than a simple test booklet and answer sheet and in many cases must be individually administered. These two aspects have generally limited the application of perceptual-motor tests, because of the difficulties traditionally associated with the calibration and maintenance apparatus tests and the need to test large numbers of individuals for the military services. The development of solid-state electronic components and the increasing availability of low-cost computer terminals have eliminated the majority of the difficulties formerly associated with the measurement of perceptual-motor abilities and have brought about a renewed interest in the use of such measures in the selection of Air Force personnel. The use of two tests of psychomotor coordination for the selection of pilot trainees is now being evaluated; over 2,500 individuals from the Reserve Officers' Training Corps, Air Force Academy, and Officer Training School have been tested. This testing program will continue and eventually other tests of perceptual-motor abilities will be developed and evaluated. In addition to measures of basic perceptual-motor abilities, measures of integrated abilities are also being developed. These measures are derived from computer-controlled monitoring of performance in flight simulators and are indicative of how quickly and how well an individual can learn to perform a task which demands high integration of a number of perceptual-motor abilities.

**Utilization:** Tests of perceptual-motor abilities may be used by recruiting and assignment agencies and by Air Training Command for the selection and classification of both enlisted personnel and officers.

**Benefits:** The use of tests of perceptual-motor abilities will result in the reduction of attrition from training with a corresponding reduction in training costs.



Two-Hand Coordination Test Using Portable Psychomotor Test Device.

### Title: Advanced Research on Adaptive Testing Systems

**Description:** The policy of the Air Force has been to develop uniform standardized aptitude tests for all enlistment applicants. These tests must be as short as

possible, accurate at all levels of ability, and valid for training and performance criteria. When every applicant for enlistment must be administered the same test, compromises in test design are necessary and accuracy of measurement is limited to a range around the mean of the ability spectrum. This means that misclassification of an applicant is more likely to occur in the ability regions which are outside the range of best measurement. Adaptive testing is a strategy for tailoring the number and difficulty of test questions during test administration. The actual presentation of items reflects applicant responses, and the system avoids the presentation of inappropriate items. The topic is being studied through a combination of theoretical simulation and live testing of subjects. Research to investigate numerous aspects of adaptive testing models and supporting theory has been completed and additional efforts are underway. Studies in this field have led to a journal publication and to three papers presented at professional meetings. AFHRL is a recognized leader in this field with Dr. Malcolm J. Ree receiving the Air Force Association's Dan Berkant award for his research.

**Utilization:** Adaptive testing will be used by the Air Force Recruiting Service and by the Army Military Enlistment Processing Command.

#### **Title: Armed Services Vocational Aptitude Battery Subtest and Composite Revisions**

**Description:** A validation study of the current Armed Services Vocational Aptitude Battery (ASVAB) subtests and composites for predicting Air Force technical training course grade is being accomplished. Analyses already completed have demonstrated the absolute and relative values of the test measures and have aided in determining which subtest should be dropped from or replaced in future ASVAB forms. On the basis of Air Force and other service validations, changes were made in ASVAB Forms 8, 9, and 10. These changes should increase the validity and reliability of the battery. These analyses have identified optimal subtests and subtest weights for Air Force composites. Implemented changes will enhance battery validity and insure fairness for sex and race subgroups.

**Impact/Utilization:** ASVAB is used for the initial screening and classification of all non-prior service applicants. In this context, improvements in predictive validity could enhance the utility of the applicant pool and tend to place more easily trainable personnel in each vocational area, resulting in substantial training costs savings in each of the different armed services.

#### **Title: Development and Validation of Armed Services Vocational Aptitude Battery**

**Description:** This continuing program provides the Air Force with efficient and effective instruments for the selection and assignment of airmen. In response to the need for a joint-services test, the Armed Services Vocational Aptitude Battery (ASVAB) has been extensively modified and expanded to provide a single battery which can be effectively utilized by all armed services. AFHRL continues to serve as the lead laboratory in this effort. Validation data on current ASVAB subtests and composites have been analyzed for 13 Air Force technical training course clusters. Data on 35 of these, many of which included separate sex and race validities, were sent to the Deputy Assistant Secretary of Defense on 24 October 1977 to assist the Secretary of Defense General Counsel in reviewing legal defensibility of the tests. Other validity studies on subjects entering the Air Force in 1977 and 1978 have been completed. These data were analyzed in ways which assisted both in identifying content areas for Forms 8, 9, and 10 of the battery and in revising Air Force composites. The final version of the new ASVAB forms (to be designated 8, 9, and 10) have been developed and accepted by all military services for implementation. This current version will consist of six parallel test forms (rather than three as in prior ASVAB versions) and a longer Armed Forces Qualification Test (AFQT) composite for service selection. These changes will result in higher reliability and validity as well as much less compromise in comparison with past ASVAB test forms.

**Impact/Utilization:** ASVAB will be revised periodically in accordance with Air Force Regulations 33-6 and 35-8. Emphasis continues to be directed toward making selection more effective. The ASVAB is used by the Air Force Recruiting Service and by all major commands. The ASVAB is also used in a joint service high school testing program and is the selection and classification instrument used by all armed services.

**Benefits:** Through the use of the ASVAB, the armed services have been able to select and effectively utilize a quality enlisted force. Although there is no direct method to compute the total dollar impact of the ASVAB in terms of reduced training attrition and in increased operational effectiveness, if one assumes that the increased efficiency in the force management yields a modest increase in productivity of only 5% in the Air Force, the annual gain is equivalent to about 5000 workyears, which would translate into an Air Force value of approximately 30 million dollars.

#### **Title: Development and Validation of Officer Selection Tests**

**Description:** A new form of the Air Force Officer Qualification Test (AFOOT-0) is scheduled for development in 1981. Major revisions are not planned; however, based upon inputs from pilot and

navigator selection research, restructuring of certain composites may be effected. An extensive validation study using Officer Training School students is underway. Students will be tracked through OTS, technical schools, and their first year in a job setting. At a later date, personnel from the Air Force Academy and Reserve Officers Training Corps will be tracked in a similar manner.

**Utilization:** The selection procedures developed will be used by Air Training Command.

**Benefits:** The Air Force will benefit from this research program through lower officer training attrition and improvement in the quality of the officer force.

**Title: Development of an Appraisal System for USAF Civilian Personnel**

**Description:** The development of a comprehensive management system for encouraging excellence in job performance of Air Force civilian employees is underway. The system has four major modules: (a) Senior Executive Service Appraisal, (b) Merit Pay Appraisal, (c) Job Performance Appraisal, and (d) Promotion Potential Appraisal. The procedures for distributing bonuses to senior executives are based on job performance evaluations and have been developed and made operational as of 1 Oct 79. A similar system for evaluating general managers (GS-13 to GS-15) and distributing merit pay among these managers is under development. Non-executives or general managers will be evaluated by the job performance module which is also under development. This system includes a module for each element indicated above. The job performance module pivots upon a supervisor-worker agreement of the dominant elements, or tasks, of the job upon which ratings should be rendered and includes a system establishing the priority of those tasks and standardizing the ratings across positions. The promotion potential model, also under development, will include biographical, experimental, aptitudinal, and performance-based variables which will be collected across the full spectrum of Air Force employees. Experts in each vocational area will define the variables critical to promotion in that area through a policy-capturing exercise. Although the requirement for the job performance and promotion efforts predate the Civil Service Reform Act of 1978 by 2 years, it is believed that the evolved systems are precisely in accord with the objectives of the act.

**Impact/Utilization:** The results of this effort will be used for all civilian employees throughout the Air Force. It will be the basis for selection for promotion, special assignments, training, award of special pay, and other personnel actions. This system will permit management and career development of the civilian workforce based on the results of experimental studies. It is believed that, over time, this system will be seen as responsive to the needs of both management and employees.

**Title: Screening of Prospective Air Traffic Control Operators**

**Description:** The Air Force Communications Command has observed that an excessive number of individuals either fail in Air Traffic Control Operator Training, or fail to achieve and maintain field certification after completion of training and assignment to an operational unit. The problem of Air Traffic Control Operator selection has been investigated at length by the Federal Aviation Agency, and techniques developed by that agency may be applicable to the Air Force. Initial investigations will center around improved screening using the composite scores obtained from the Armed Services Vocational Aptitude Battery. Later, new testing procedures will be evaluated, including the FAA selection tests and computer-administered simulations of the Air Traffic Control operator's tasks. Data obtained from test administrations will be compared to performance during training and later in the field setting to determine optimal selection procedures.

**Utilization:** The selection procedures developed will be used by the Air Force Communications Command.

**Benefits:** Use of the improved selection procedures will reduce the attrition from training and from the field, with an associated cost savings. Results may also provide for the identification of individuals who not only will succeed in training but also will prove better able to perform Air Traffic Control operator duties, thus improving the quality of the force.

**Title: Selection for Navigator Training**

**Description:** The Undergraduate Navigator Training program has experienced an unusually high attrition rate in recent years. Despite a major reconfiguration of the Air Force Officer Qualifying Test (AFOQT) Navigator-Technical composite, additional research is needed to investigate the problem. The current research approach centers around the development of an experimental job sample task based upon several elementary navigation concepts, design of an experimental procedures learning task, revision of two abstract reasoning tests which have demonstrated very useful test score/undergraduate pilot training (UPT) performance validity, and a Navigator Attitudinal Survey which shows promise for identifying likely self-initiated eliminees (SIEs). Data obtained from test administration at Mather AFB will be compared to undergraduate navigator training (UNT) performance as well as uses for tracking each student through Combat Crew Training School (CCTS) and the first year in an operational setting.

**Utilization:** The selection procedures developed will be used by the Air Training Command.

**Benefits:** Use of an improved navigator selection system will reduce attrition from UNT and will assist

in identifying superior navigators in an operational squadron.

**Title: Selection for Pilot Training**

**Description:** The Air Force Officer Qualification Test Composite has long been the primary selection tool for entry into Undergraduate Pilot Training. This new research program will investigate the feasibility of using tests which measure psychomotor ability as well as performance on a desk-top flight simulator. The program calls for testing large samples of pilot qualified students from the Reserve Officers' Training Corps, Air Force Academy, and Officer Training School commissioning sources on experimental psychomotor and learning sample measure. Another major segment of the program

involves an extensive evaluation of the Air Force Flight Screening Program. In addition to the new tests which measure psychomotor ability, a Pilot Attitudinal Survey will be administered to assist in identifying the most suitable type of aircraft for each student and the identification of students who are most likely to be self-initiated eliminees for reasons other than academic or flying training deficiencies.

**Utilization:** The new selection system will be used by Air Training Command.

**Benefits:** The benefits of the new system will take the form of reduced attrition from Undergraduate Pilot Training, the thorough examination of the effectiveness of the Flight Screening Program, and the identification of superior pilots in an operational setting.



Portable Flight Simulation Testing.

## SIMULATION TECHNOLOGY FOR TRAINING

**Title: Advanced Simulator for Pilot Training Aerial Refueling Visual Simulation—Engineering Development Phase II**

**Description:** The objective of this project was to further expand the capabilities of the Advanced Simulator for Pilot Training (ASPT) to assess the minimum level of detail required to perform receiver aerial refueling tasks in a B-52 aircraft

simulation. This capability was requested by the Simulator System Program Office (SIMSPO) at the Aeronautical Systems Division, Air Force Systems Command. SIMSPO is responsible for providing the Air Force major commands with all simulator equipment required to meet operational training requirements for forthcoming simulations, including the receiver aerial refueling task. The inherent flexibility of the ASPT system was able to best

provide the numerous experimental conditions required to determine the impact on pilot performance of such variables as field of view (FOV), tanker image detail, and day/night visibility. A list of the necessary additional ASPT system operational capabilities was constructed based on the receiver aerial refueling mission scenario, behavioral research, and SIMSPO requirements. SIMSPO requirements necessitated the generation of one-window configuration for replicating the B-52 simulator FOV. Several different KC-135 tanker models were developed with various levels of detail, all of which differed from those used in the Phase I research performed in FY 78. Strategic Air Command pilots current in the B-52 aircraft were used as subjects in the study. Minor adjustments were made to the ASPT A-10A flight dynamics and control forces in an attempt to approximate the B-52 aircraft handling qualities. This was accomplished by adjusting the thrust, drag, pitch, roll, engine response time, and gross weight factors. A dynamic graphics display was programmed to facilitate the instructor/operator in guiding the pilot into position.

**Impact:** The engineering modification of the ASPT system which resulted in the additional capability to perform receiver aerial refueling simulation will be utilized in a number of ways. One research study has been performed addressing FOV and tanker image detail requirements; a second study was completed to assess the minimum level of tanker detail needed for a B-52 pilot to accomplish aerial refueling. It is also anticipated that the capability will be utilized in the training/research programs for the A-10A and F-16 aircraft.

**Benefits:** The study conclusions may be effectively utilized in specifications of future flight simulators having the potential of resulting in considerable dollar savings, reduced training time, enhanced operational readiness, and increased capabilities and training effectiveness.

#### **Title: Advanced Simulator for Pilot Training Computer Update**

**Description:** The Advanced Simulator for Pilot Training (ASPT) system was delivered with a single Systems Engineering Laboratory (SEL) 86 Computer to perform flight and motion cueing simulation and performance measurement on two T-37B cockpits. The iteration rate of this system resulted in a lack of confidence in motion research

results. Improvement of the simulation fidelity required additional computer power. The single SEL 86 was replaced by three SEL 3275 control processing units in FY 78. This required a complete restructuring of ASPT software to provide functionally separated 30-Hz aircraft simulation, doubling the basic iteration rate of the system. Each cockpit is independently controllable, permitting simultaneous simulation of two aircraft with completely different flight and performance characteristics. At the time of this computer update, the ASPT was being used to simulate both the T-37B and A-10A aircraft flight models. In order to simulate the F-16 aircraft with its advanced avionics systems, it was necessary to perform an additional update to the ASPT computer configuration in FY 79. The three SEL 3275 computers were updated to SEL 3275 configurations by the addition of high-speed floating point arithmetic packages, and two additional SEL 3275 computers were integrated into the system. ASPT is currently being used for research and training in A-10A and F-16 lead-in training and air-to-surface familiarization.

**Impact:** The ASPT computer system is now operational and in use by AFHRL in on-going research.

**Benefits:** The increased capabilities provided through the high fidelity simulation of the newest aircraft in the Air Force inventory vastly improve the research potential of the ASPT system. A 30-Hz iteration rate is expected to allow simulation of all known aircraft; however, sufficient computer power exists with the ASPT system to research the effects of a 60-Hz iteration rate. The current ASPT system will permit evaluation of g-seat, g-suit, visual, and motion cueing requirements in a variety of aircraft and/or environments; i.e., air-to-surface, air-to-air, hostile, tactical, and aerial refueling. Advanced training features to include extended operation and system performance measures can be used concurrently in the exploration of these parameters. Of critical importance is the fact that the research can effectively anticipate actual procurement windows.

#### **Title: Flight Simulator Runway Visual Textural Cues for Landing**

**Description:** The lack of adequate flare and final touchdown visual information cues has been a longstanding criticism of flight simulators in general. One typical fault often suggested to exist is the lack of

adequate textural information in the visual scene that is needed to provide good cues for depth perception. The flexibility of computer-image generation (CIG) which permits rapid variation of the content of the visual scene was chosen to permit experimental investigation of visual textural cues for landing. The experimental approach consisted of having experienced instructor pilots fly straight-in approaches and landings in the T-37 simulation on the Advanced Simulator for Pilot Training. Seven different runway scenes were used in order to compare pilot performance differences between different levels of visual texture cues. Six of the pilots also flew touch-and-go landings at the Air Force Flight Test Center in order to provide data concerning typical pilot landing performance in the T-37 aircraft. The simulated aircraft average vertical velocity at touchdown decreased systematically from 201 feet/minute for the night runway without the touchdown (TD) zone lights to 136 feet/minute for the day runway with 4-foot texture patterns. The day runways alone, without the overrun, varied from 195 feet/minute for the bare bones runway to 136 feet/minute for the 4-foot texture patterns. Although these average vertical velocities were still much higher than those recorded in actual aircraft landings (32 feet/minute), the texture patterns did influence the pilot's flare and touchdown in a systematic manner. Additional visual cues might have reduced the vertical velocities even more but the limited edge capacity of the CIG scene did not permit study of other visual cues while investigating texture patterns. The presence of the TD-Zone lights in the night scene also reduced the average vertical velocity at touchdown (190 feet/minute) but this difference was not statistically significant. The presence of the runway overruns on the daytime runways limited the range of touchdown vertical velocities to a smaller range, spanning from 176 feet/minute for the Williams AFB runway to 158 feet/minute for the 4-foot textured runway. When the overrun was present, apparently the pilots used the overrun visual cues, the chevron texture patterns, and other related cues, in addition to the runway texture patterns in order to perform flare and touchdown. This resulted in reduced overall touchdown vertical velocities but apparently the more uniform (restricted range) pilot performance did not involve an optimum use of the 4-foot texture patterns. Several other data parameters also varied across runway types; however, there were no consistent differences related to runway texture patterns. The statistically significant effects with the other data parameters were most often related to differences between the night and the day runway scenes.

**Impact:** The results of this study and related follow-on studies will permit definition of the requirements for improved visual simulations and to pursue technologies for providing more adequate visual cues during the flare and touchdown. The results of this study should also have impact on defining the visual cue requirements for other low level flight environments such as contour and nap-of-the-earth flight.

**Benefits:** The current lack of adequate flare and final touchdown visual information cues in flight simulators reduces the amount of effective transfer of training from the flight simulators to the aircraft during flare and landing. Improvements in these visual cues should increase the effective transfer of training from flight simulators to aircraft during flare and touchdown. A better understanding of the requirements for low altitude visual cues should also enhance the effectiveness of low level flight simulations. This potential application will probably have even much greater impact of flying training because of the hazards and restrictions inherent in low-level flight in actual aircraft.

#### **Title: KC-135 Computer-Generated Image Modeling Requirements for B-52 Aerial Refueling Simulation**

**Description:** The purpose of this research was to identify the minimum model visual detail requirements necessary for computer-generated image simulation of aerial refueling (AR) of the B-52 aircraft by a KC-135 tanker. Three levels of detail were employed: low (200 edges), intermediate (700 edges) and high (1,400 edges). Two levels of illumination were employed: day and night. KC-135A models were constructed based upon a survey of cues employed by Strategic Air Command (SAC) pilots. Twelve experienced B-52 pilots (not less than 500 hours), who were current in the aircraft, were employed as subjects. These pilots were provided with two familiarization training sessions prior to data collection. All pilots were required to meet a training criterion of six refuelings of 1 minute cumulative contact prior to data collection. One pilot was eliminated due to inability to achieve the training criterion. The Advanced Simulator for Pilot Training (ASPT) was employed for this research. Refueling was accomplished in an A-10 aircraft configured cockpit, a circumstance which required pilots to adapt to a different throttle and stick configuration than present in the B-52. The field of view was electronically masked to approximate that

projected for the B-52 Weapon System Trainer (WST):  $\pm 24$  degrees horizontal and  $+ 24$  degrees,  $- 10$  degrees vertical, from the design eye. A T-37 aircraft canopy bow configuration was employed to provide a windscreen reference. Flight dynamics approximated those of a B-52G model in the AR envelope. However, it was impossible to provide a throttle quadrant with a neutral setting during refueling. Pilots were initialized 100 feet below and 200 feet in trail behind the KC-135 tanker. Subjects proceeded to precontact at 10 feet below and 50 feet behind the tanker. The console operator served as a surrogate boom operator to talk the pilot into position. A computerized voice synthesizer informed the pilot when contact had been achieved broken or criterion had been achieved. A criterion of one minute cumulative contact per trial was employed in data collection. These were six models—three day and three night—at low, intermediate, and high levels of detail, respectively. The subjects flew three repetitions per model during data collection, a total of 18 trials. Dependent measures included (a) total time in seconds from precontact to contact; (b) total disconnect time in seconds prior to criterion; (c) number of disconnects prior to criterion; (d) total RMS (TOTSCORE = sum of RMS deviation scores (e) through (i) as follows); (e) RMS horizontal deviation from precontact to contact; (f) RMS vertical deviation from precontact to contact; (g) RMS horizontal deviation during contact; (h) RMS vertical deviation during contact; (i) RMS fore/aft deviation of boom during contact; (j) RMS throttle movement; (k) RMS stick movement; (l) aileron power; and (m) elevator power. Subjective results from a standardized questionnaire indicated that pilots found visual cues were best represented on the complex model (1,400 edges) and preferred it for motion detection to the less detailed displays. The field of view (48 degrees by 34 degrees) was rated as satisfactory for performing the AR task. Pilots reported they adapted to the A-10 cockpit, but found the throttle response unrealistic. The objective performance results indicated that simulated day and night refueling can be accomplished with considerably less than the 1,000 edges requested by SAC. In general, performance with the austere model (200 edges) was less satisfactory than that of either the intermediate (700 edges) or complex (1,400 edges), but not dramatically so. Overall differences between intermediate and complex models were negligible.

**Impact:** The present results indicate that detail levels of approximately 700 to 1,000 edges can be satisfactorily employed for simulated refueling, provided a representative selection of cues is portrayed. Both the present study and previously accomplished research found that a field of view of about 48 degrees by 34 degrees is satisfactory for training in the AR task.

**Benefits:** The results of this research will be used in procurement specifications for the B-52 WST, as pertains to requirements for AR simulation requirements. Such data are useful in assuring that such procurement specifications are cost-effective in meeting training requirements.



Computer-Generated Image of Aerial Refueler (KC-135).

#### **Title: Pilot Performance in Simulated Aerial Refueling as a Function of Tanker Model Complexity and Visual Display Field of View**

**Description:** Two experiments were conducted in the Advanced Simulator for Pilot Training (ASPT) to determine tanker detail level and field-of-view (FOV) requirements for aerial refueling. This research was performed to provide data to the Simulator System Program Office (SIMSPO) at the Aeronautical Systems Division, Air Force Systems Command, which specified the aircraft and FOVs to be simulated. The purpose of the studies was to determine the effects on pilot performance of tanker model level-of-detail in the context of display systems the SIMSPO is procuring. The adequacy of three detail levels and five different FOVs was assessed. The three detail levels employed for both experiments varied according to the visual complexity of the KC-135 tanker aircraft. Study 1 simulated the A-10 and F-4 aircraft and employed the FOV sizes and positions for those aircraft specified by the SIMSPO. Study 2 simulated the B-52 and F/B-111 aircraft. These FOVs were based upon already-initiated simulator procurement actions. However, the FOV positions and sizes had been specified on the basis of requirements to train aircraft takeoff and landing in the simulator. A determination of FOV adequacy to train aerial refueling (AR) also was desired. In addition to the four FOVs just discussed, the full FOV in ASPT was employed in both studies to provide an additional basis of comparison. Six pilots from the Tactical Air Command (TAC) and six from the Strategic Air Command (SAC) served as subjects for this research. Participating SAC pilots judged the locations of the B-52 and F/B-111 FOVs to be satisfactory at AR precontact and contact positions. The TAC F-4 and A-10 pilots, however, raised the FOV an average of 12 degrees to accomplish AR. A-10 pilots found that the 12-degree change interfered with their ability to take off and land in the simulator, and F-4 pilots



experienced great difficulty with both takeoff and landing. In Study 1 (A-10 and F-4), difficulty in AR was shown to be a function of model complexity and FOV size. As complexity increased, the average time needed to complete AR and the average number of disconnects decreased significantly. As FOV size increased, the average time to criterion and the average number of disconnects decreased significantly. The performance measurement results from Study 2 (B-52 and F/B-111) were similar to those in Study 1 described above. Overall receiver aircraft oscillation, as a function of model complexity, was insignificant for TAC pilots but highly significant for SAC pilots. Oscillation as a function of FOV was significant for all pilots. In debriefing, the pilots reported that many of the visual cues they normally use to refuel were not present, even on the complex model employed in this research.

*Impact:* Results from the refueling task indicate the largest SIMSPO-specified FOV was far superior to the smallest one but not as effective as the full FOV. Similarly, the most complex model was superior to

the least complex. FOV and model detail level are important variables in AR simulation, as is placement of tanker visual cues. Because many of the cues they ordinarily use were missing, the pilots learned to utilize cues existing in the simulation. When the model did not include as much detail (e.g., three-dimension engine nacelles) or when less of the tanker was visible in a smaller FOV, the performance deteriorated.

*Benefits:* These results indicate that no less a tanker detail level than that associated with the complex model in this study should be employed for AR simulation so that pilots will have sufficient visual cues to perform the task. Also, care should be taken to construct the model with a better selection of frequently employed AR visual cues than that utilized in the present study; even a complex model is inadequate if necessary cues are lacking. The results further suggest that the effectiveness of the one-window display for AR simulation training is limited and that a single window cannot be used to train both transition and AR in TAC aircraft simulators.

## TECHNICAL SUPPORT

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### **Title: Comprehensive Occupational Data Analysis Programs**

*Description:* The Comprehensive Occupational Data Analysis Programs (CODAP) system was developed in response to the need for an efficient and effective method to identify and classify jobs in a rapidly changing Air Force. The basic input to this system is information provided by a large number of supervisors and job incumbents in the occupational area being studied. Because the data are collected at the worker-task level, Comprehensive Occupational Data Analysis Programs (CODAP) provides a base of information which may be viewed in many ways and address new and unanticipated management questions whenever they arise. The technical support during the past year has been aimed at providing an easy method to restructure and summarize these data for higher-level management in more widely diverse functional areas.

*Impact/Utilization:* In addition to its operational usages in developing and validating the content of training programs, CODAP is being used to address questions about the requirements of jobs which will be integrated into the initial personnel selection process and eventually into the person-job match (PJM) model. Although developed by the Air Force, all branches of the United States Department of Defense, as well as the British, Canadian, and Australian Forces, have incorporated CODAP into their operational programs. In the non-DOD public sector, many state and country governments are beginning to use CODAP to validate their traditional testing and selection procedures, and at the same time develop performance evaluation criteria. Educational institutions are using CODAP to modify the curriculum of the vocational education programs.

**Benefits:** The traditional benefit of providing relevant training is still continuing and the most recent improvements to the CODAP system have been designed to facilitate that operational program. The near-term benefits will be realized with the results of the aptitude requirements project, which used the historical CODAP data base of all occupations along with enhanced programming capabilities to realign entry-level aptitude requirements across Air Force career fields. The next level benefit will be improved definition of job requirements for integration into the overall person-job match (PJM) model under development. The long range benefit will be the spin-off from the public sector activities. As each state is attempting to assess the skill pool available to attract new business, the CODAP system is providing a common basis by which a National Skills Assessment Program may be developed and provide the Department of Defense with an accurate picture of the civilian labor force from which it draws.

**Title:** File Item Data Organizer

**Description:** The File Item Data Organizer (FIDO) evolved from the need of research efforts involving present and longitudinal sample selection where codes contained in the AFHRL unique data base had to be identified and interpreted by research scientists with English meanings for coded information including: description of the code, frequency of occurrence, and other descriptive statistics. FIDO also contains an automated inquiry/retrieval system, vital for the establishment of data bases for personnel research projects and probe analysis to determine the feasibility of proposed major research efforts involving data bases. FIDO is on-line on the AFHRL UNIVAC 1108 computer system. It consists of 677 Air Force and DOD defined data elements used in automated Air Force Personnel Data Systems; examples are security classification, grade, Air Force Specialty Code, and major academic field. Present efforts are to provide more accurate and timely data by improving the update procedures now in use and by developing procedures to get this information directly from the Air Force Data Systems Design Center AFM 300-4 data base which is supplied to AFHRL monthly by magnetic tape.

**Impact/Utilization:** FIDO directly supports virtually all facets of personnel and manpower research across AFHRL divisions. Many research

efforts involve longitudinal studies of specific samples cutting across many different data files and code values over varied time periods. Automated availability of Air Force and DOD defined data elements, as well as other nonstandard data elements, with their data items and meanings across time when combined with heavy usage by programmers/analysts represents a sizeable savings in workhours which would otherwise be spent in researching hundreds of manuals, and/or microfiche by hand in order to find the needed code properly identified for a given historical time period. As implemented, scientists may, on retrieval, specify all code values in effect dating back to the establishment of a given data element or may specify inclusive dates and get only those codes in effect during the interval in question. The data can be displayed on a remote interactive terminal or a hard-copy may be requested showing title, data name, definition/explanation, code values, effective dates, and explanation of code values.

**Benefits:** FIDO makes it possible to carry out research studies which would be prohibitive in terms of workhours required without an automated inquiry/retrieval system.

**Title:** Human Resources Research Data Base

**Description:** A series of data bases containing information on personnel and training systems has been developed. The data bases are stored on magnetic tape. Software to process, organize, and display selected information from a single data base and to consolidate information on a common subgroup from two or more data bases has been implemented. The data bases include records on all active duty Air Force enlisted and officer personnel at 6-month intervals; Air Force Reserve and National Guard Personnel; records of graduates from basic military training, technical training, and flying training programs and from the Officer Training School and Reserve Officers' Training Corps commissioning programs; and records reflecting separations and losses from active duty. Special-purpose longitudinal files have been derived from these data bases. These longitudinal files significantly reduce data processing requirements in many personnel and training research studies.

**Impact/Utilization:** The data bases represent a low-cost means of acquiring and maintaining information used in the development and validation

of personnel selection and classification instruments, development of assignment procedures, derivation and revalidation of promotion systems, and special-purpose analyses to determine the long-range impact of specific personnel and training policies.

*Benefits:* Availability of these data bases makes it possible to carry out studies on numerous aspects of the personnel and training systems which otherwise would not be feasible. A conservative estimate of an annual cost-avoidance of 500 thousand dollars can be attributed to the use of these automated data bases as an alternative to manual screening, selection, and automation of records maintained in archival storage.

#### **Title: Officer Effectiveness Report System**

*Description:* Officers are normally given Officer Effective Report (OER) evaluations once a year. There are several uses for the evaluations: (a) a tool in determining the best individuals qualified for promotions, (b) a tool for making assignments, (c) a counseling device, and (d) a general personnel management tool. In addition, these reports aid in the monitoring of the rating trends. The automated OER report system uses the OER records, which have been transcribed to magnetic tape, to produce summary reports on a quarterly and yearly basis for grades of lieutenant through colonel, separately. The reports aid assignment managers, career monitors, personnel managers, and OER monitors.

*Impact/Utilization:* The OER summary reports are used by senior Air Force managers, the promotion secretariat, career monitors, and OER monitors.

*Benefits:* The Air Force is in a better position to monitor the OER system and its built-in controls as a result of the summary report system developed by AFHRL.

#### **Title: Technical Training Graduation/Elimination Rates**

*Description:* Summary reports for Air Force enlisted personnel who terminate technical training in each quarter of the fiscal year and aggregated over the fiscal year are prepared quarterly. These matrix format type reports contain statistics (for all individuals who terminated a particular course in a specific quarter of the fiscal year), such as frequency counts and percentages for reasons for termination of training; average Mechanical, Administrative, General, Electronics and Armed Forces Qualification Test scores for graduates and eliminees; minimum selector aptitude index (AI) score for entry into the course; and average time in training for graduates and eliminees. All of the aforementioned frequency counts and percentages for all individuals are reported by race, sex, race/sec, 4-year or 6-year enlistment, academic education level, and mental category.

*Impact/Utilization:* The reports are used by personnel systems managers to track graduation/elimination rates of Air Force enlisted personnel from basic resident technical training courses.

*Benefits:* The reports are being used to focus on total attrition from technical training courses with special emphasis on the high-cost courses; and also for briefings at higher echelons, and for updating trends tables.

## **TECHNICAL TRAINING TECHNOLOGY**

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#### **Title: Development of Efficient Computer-Assisted Instruction Authoring Procedures for Use in a Technical Training Environment**

*Description:* The instructional effectiveness of computer-assisted instruction (CAI) has been demonstrated repeatedly for a large variety of instructional applications. The principal drawback of

CAI has been the cost of developing and delivering CAI materials. This effort has concentrated on the development tasks to decrease development costs. CAI lesson development times may range from 100 to 400 hours to prepare 1 hour of instructional material. Often a team approach is employed, involving a subject matter expert, an instructional programmer, and a computer coder. This

requirement for specialized personnel expending many workhours to develop one instructional hour is the chief reason for high development costs. This effort developed a set of procedures which allow existing Air Force technical training personnel to efficiently prepare instructional materials and employ instructional strategies. The procedures are structured about an author-editor that allows the lesson developer to sit at a terminal and concentrate on material production since lesson design is somewhat guided by the editor, and the coding of the computer is automatic. Graphics displays are easily prepared through the use of a bit-pad digitizer. The results of this effort are documented in AFHRL-TR-79-74, *Computer-Assisted Instruction in the Context of the Advanced Instructional System: Materials Development Procedures and System Evaluation*.

**Impact/Utilization:** The authoring procedures are in use by several ATC courses at Lowry Technical Training Center. Plans to extend this capability to several Tactical Air Command and Strategic Air Command installations are being formulated. Relevant lessons on other computer-based instruction (CBI) systems are being reviewed for possible use on the Lowry CBI system.

**Benefits:** Evaluation information indicates that lesson development times average about 85 development hours per student hours of contact. This indicates a higher degree of efficiency in the lesson development process. It also appears that strategies employed are reducing student failure rates. CBI users have been pleased with the results and the enhanced capabilities for delivering and developing instructional materials.

#### **Title: Dual-Fiche**

**Description:** The microfiche medium offers proven advantages in the management, storage, and retrieval of information. Advances in computer-output-to-microfiche (COM) technology, especially, brings together the efficiencies of computer processing and the cost advantages of microfiche. COM technology, however, deals exclusively with, and is designed to accommodate, narrative information (in traditional vertical formats), which has limited its use in training (where pictorial and horizontal formats are commonplace). While both narrative-only and pictorial-only microfiche can be produced, a combination of the two formats presents

production problems. The dual-fiche concept separates the production of the narrative, or text, component from the production of the pictorial, or graphic, component yet combines the two types of information at the point of use (i.e., the microfiche reader). The dual-fiche product is a fiche "sandwich" — one fiche containing text or narrative information, the second fiche containing graphics. Both images are projected simultaneously, with words and pictures in perfect registration. This development brings the power of COM to bear directly on the problems of writing and revising instructional materials. The dual-fiche approach was developed under Air Force Contract F-33615-77-C-0057 by the Denver Research Institute and utilizes the operational context of the Advanced Instructional System (AIS) at Lowry AFB. The effort is documented in AFHRL-TR-79-6, *Microfiche Application in an Individualized Self-Paced Learning System*.

**Impact/Utilization:** The contract effort resulted in a scenario which could place the development and maintenance of instructional materials in the hands of Air Training Command AIS instructors. Using an interactive computer terminal, an instructor may write or edit materials which, upon completion, are transferred to tape. The tape is then loaded into a COM machine which produces the microfiche. As this effort is a demonstration of the approach and the technology, a fully operational program was not implemented. Further developments and refinements are anticipated.

**Benefits:** The dual-fiche approach expands instructional material development and maintenance capabilities, greatly reducing production turnaround times. Full implementation carries a potential cost avoidance as well as increased efficiencies. Most importantly, the scenario places both the means and the technology itself at the disposal of learning center instructors—eliminating reliance on time-consuming, traditional microfiche methodologies.

#### **Title: Evaluation of PLATO IV in Three Air Force Medical Courses**

**Description:** Training sufficient numbers of skilled medical personnel in less time than required by costly conventional methods is of prime interest to medical administrators. Unfortunately, there is little empirical evidence to assist decision-makers in choosing among individualized, self-paced

alternatives to lecture. To reduce this data gap, this medical training study was conducted to provide answers to two major questions. (a) Do computer-assisted instruction (CAI), programmed text and lecture differ in instructional effectiveness in courses varying in difficulty? (b) Do students who differ in characteristics (e.g., aptitude level and motivation) achieve more in less time under computer-assisted instruction, programmed text or lecture? The following technical reports document this study: AFHRL-TR-77-17, *Computer Assisted Instruction in Air Force Medical Training: Preliminary Findings*, and AFHRL-TR-79-76, *Computer assisted, Programmed Text, and Lecture Modes of Instruction in Three Medical Training Courses: Comparative Evaluation*.

**Impact/Utilization:** From an overall standpoint, computer-assisted instruction (CAI) was found to be more instructionally effective and efficient than programmed text or lecture. The more difficult the course, the greater the impact of computer-assisted instruction on achievement. However, the degree of effectiveness and efficiency varied with aptitude level and course difficulty. For example, CAI increased low aptitude student achievement as much as 18 percentage points more than low aptitude lecture controls in the difficult course and 7 percentage points more than low aptitude programmed text controls in the course of average difficulty. No significant differences in achievement were obtained in the less difficult course. In contrast, high aptitude CAI students completed instruction in 33% less time than their high aptitude lecture counterparts. Though high aptitude CAI students generally completed instruction in 30% less time than low aptitude CAI students, low aptitude CAI students achieved more in 17% less time than low aptitude programmed text controls. Hence, the graphics capabilities of interactive CAI appear to compensate for the typically lower reading capability and achievement motivation of lower aptitude students such that their CAI achievement approximates the achievement of higher aptitude students under lecture or programmed text conditions.

**Benefits:** This evaluation has provided decision-makers with evidence bearing on the instructional effectiveness and efficiency of CAI compared to lecture and programmed text. To optimize the effectiveness and efficiency of CAI, programmed text or lecture, learner characteristics profiles were provided which permit differential assignment of learners to instructional modes which were found

more effective for them. Based on this evidence, CAI has been extended to several other courses within medical training.

#### **Title: Feasibility of Computer Applications for Task-Oriented Training in the Aircraft Armament Systems Career Field**

**Description:** The Air Force On-the-Job Training (OJT) program is designed to prepare its personnel to perform tasks required to support the mission of the Air Force. Management and evaluation of the OJT program has historically been a recognized problem. The administrative problems associated with scheduling students, instructors, instructional materials and resources for OJT are sufficiently complex that inadequate training can result. Task proficiency evaluation in OJT involves a great number of judgments by the OJT supervisor/trainer regarding the adequacy of an individual's performance. Moreover, the requirement of observing trainee behavior in order to perform these task evaluations is time-consuming. Ideally, these observations should be standardized across evaluators and trainees so that advancement in skill level can be assessed fairly. Better identification of training requirements would also result in improved training. More accurate knowledge of OJT costs and unit OJT capability and capacity could lead to better management of the total technical training system. Advancements in computer technology, especially in the field of computer-managed instruction systems (CMIS), have reached a level where it may be feasible to support some of these OJT training and management requirements. The purpose of this study was to evaluate the potential for various CMIS applications to improve the management of unit level training. A survey of the OJT environment of the 46230 Aircraft Armament Systems Specialist career field within the Tactical Air Command was conducted. Based on the results, a detailed training system analysis was performed for the F-15 weapon system. Specific function within the weapon system which could be accomplished/supported by computer were identified and specific recommendations considering trade-offs were made for expansion of computer-based technology into the OJT environment.

**Impact/Utilization:** The recommendations of this study were based on observations restricted to one major command and essentially to one weapon system. However, the potential applications identified should be applicable to OJT as practiced

throughout the Air Force. As such, they are of interest to training policy and practice managers at command and staff levels, and are reported in AFHRL-TR-79-61, *Feasibility of Computer Applications to Mission-Oriented Training in the Aircraft Armament Systems Specialist Career Field*.

**Benefits:** Since 70% of the Air Force technical training requirement is accomplished through the OJT program, the potential payoff of computer support of training and management requirements within OJT is great. This is especially true in terms of improved training quality and increased unit capability to meet operational requirements.

#### **Title: Feasibility of Low-Cost CAI/CMI System**

**Description:** The objectives of this effort were the definition and specification of a low-cost, computer-assisted instruction/computer-managed instruction (CAI/CMI) system for Air Force resident technical training. The functional CAI/CMI requirements were determined by surveying potential Air Training Command user personnel. Computer architectures were then surveyed to identify candidate systems capable of supporting those functional requirements. Terminal hardware devices and communication systems were also surveyed in order to describe an economical set of input/output devices and communications interfaces for satisfying the functional requirements. Additionally, various computer programming languages were analyzed to determine the most cost-effective language for CAI/CMI programming. Finally, existing CAI/CMI applications programs were surveyed to determine the extent to which they met Air Force training needs and to identify potential sources of applications software for the low-cost system. A system specification was prepared to describe the functional requirements and capabilities of the low-cost system. Parameters for the low-cost system were based on the following assumptions: (a) primary initial implementation will be in resident technical training, (b) the system will be a dedicated local system with a modular approach to expansion, and (c) the system will support 500 students per shift, in five courses with 1,500 hours of instruction—10% CAI and five CMI transactions per student per shift. The surveys of computer architectures, terminals, communications, and support software identified candidates from these areas for the low-cost system. A functional specification describing the requirements for the low-cost CAI/CMI system was

produced. The suggested system configuration is based on currently available (1979) hardware and includes (a) computer and peripherals, (b) student and administrative terminals—alphanumeric, graphics/color, and high resolution graphics, (c) management terminals—forms reader, printer, and controller, (d) programming language, (e) support software, and (f) applications programs. AFHRL-TR-79-42, *Low-Cost Computer-Aided Instruction/Computer-Managed Instruction (CAI/CMI) System: Feasibility Study*, documents this study.

**Benefits:** This effort defined and specified an operationally configured system as constrained by the stated parameters and costing approximately \$500,000, that can support the CAI/CMI functional requirements of Air Force resident technical training.

#### **Title: Formulation and Validation of a Computerized Instructional Adaptive Testing Model**

**Description:** Testing is an important aspect of any training system. Since the Air Force conducts one of the largest training efforts in the world, it must be concerned with any procedure which tests more efficiently. The theory and methodology of adaptive testing, developed largely in the current decade, provide such a procedure. Basically, adaptive testing uses one of a variety of possible algorithms to select the next best item to present to the examinee. All procedures have, in common, the fact that an item selected for presentation is based on the unique set of responses given up to that point, hence the term "adaptive." The intent of the current effort was to develop and test a new algorithm for adaptive testing holding promise for increased testing efficiency. Basically, the model uses various item selection procedures and, based on the accumulating responses, makes predictions concerning items not yet presented. Predictions are based on matching the subject's present response vector to a data base of previously tested subjects. The matches so obtained form the basis of computing conditional probabilities for as yet unrepresented items. A sequential decision procedure is then used to assign mastery status based on actual and predicted item responses. Several parametric variations of the model were explored using simulated data sets and compared to a control version. The results indicated that the model needed approximately 25% of the items required by the control version while achieving smaller loss (better classification accuracy). These results were

corroborated when the model was tested on actual Air Force block testing data sets. The adaptive testing model was developed under Air Force Contract F33615-77-C-0071 by Control Data Corporation. The effort is described in the technical report AFHRL-TR-79-33, *Computerized Instructional Adaptive Testing Model: Formulation and Validation*.

*Impact/Utilization:* The model has been formulated, tested, and validated using simulated data and data collected from an actual technical training course. Since the preliminary results are so promising, the AFHRL is planning an implementation study to validate the performance of the model in a live testing mode.

*Benefits:* The primary benefits of the adaptive testing model are reductions in required testing time and improved diagnostics for remediation at test completion. Since the model requires markedly fewer test items to achieve better classification accuracy, substantial training manpower reductions are possible.

#### **Title: Learning Strategies and Skills Training Program**

*Description:* Research has documented that most students tend to employ less than effective and/or inefficient methods for acquiring, retaining, or applying information. To acquire, retain, and appropriately apply knowledge, it has become evident that methods designed to organize information for presentation to learners are of beneficial, yet limited, effectiveness. In contrast, strategies which the learner finds useful in transforming information through personal effort are likely to be "owned," and retained and to contribute to increased performance. Programmatic research was initiated (a) to identify and compare the effectiveness of alternative learning strategies upon learner performance, (b) to incorporate effective strategies and interactive practice materials within a systematic training program, and (c) to empirically validate the performance of strategies-trained and untrained students. Some of the strategies included have been (a) various mnemonic devices, (b) imagery elaboration, (c) paraphrasing, (d) visual networking, (e) goal-setting, (f) distraction desensitization, and (g) formal peer interaction. These findings are documented in AFHRL-TR-78-63, *Systematic Training Program for Enhancing Learning Strategies and Skills*.

*Further Development:* and AFHRL-TR-78-64, *Learning Strategy Training Materials: A Selected Subset*.

*Impact/Utilization:* Strategies-trained students performed 17% to 40% better than untrained students on technical subject-matter achievement tests. Low reading aptitude students achieved more under imagery strategies than did low reading aptitude controls under the paraphrasing or the untrained strategies condition. Visual networking strategies students scored 26% higher on delayed retention achievement tests than controls in the untrained group. In most cases, high reading aptitude students achieved more than lower reading aptitude students.

*Benefits:* Arming learners with generalizable strategies and skills for coping with large amounts of technical information would appear to be a more rational and efficient approach than teaching unstable specific subject-matter content. The latter approach produces a person whose job effectiveness is largely dependent on specific content. In contrast, a student who has mastered learning skills, provides a relatively independent learner who is in a better position to cope effectively and efficiently with job-technology change. The Air Training Command is considering the implementation of a learning strategies training program prior to formal coursework to increase student achievement.

#### **Title: Low-Cost Terminal Alternatives for Learning Center Managers**

*Description:* The Air Force Advanced Instructional System (AIS), originally designed in 1973 and operational by 1975, provides computer-managed instruction (CMI) and computer-aided instruction (CAI). The interactive input/output device specified by the original AIS contract and used by learning center managers and students was a plasma screen graphics display terminal which required a special communication system and a communication protocol which was not standard to the industry. The AIS terminal was a very capable device; however, the overall cost of an instructional system could be significantly reduced if the average cost of the interactive device is lowered. To provide cost-effective replacement equipment, a review of industry communications standards and an evaluation of features most available on state-of-the-art terminals was required. When the industry review was correlated with classroom functional

requirements and program frequency of use in the classroom, a set of characteristics could be identified which should be available in the target terminals. To test the concept of the new replacement system, several of the new terminals and related hardware would have to be procured and operated in parallel with the previous AIS graphics terminals after modifying selected software. An evaluation would check the effectiveness of the original characteristics predictions. Results of this study will be reported in a technical report entitled Low-Cost Terminal Alternatives for Learning Center Managers.

*Impact/Utilization:* Results of the user-needs study identified the required characteristics for a low-cost interactive terminal for use in the AIS. These characteristics were in the areas of display, keyboard, and transmission parameters. An additional constraint, cost, was added to the user requirements. The resulting requirements of the display were to present in two brightness levels the 96-character ASCII erican Standard Code for Information Interchange set on a format of at least 24 lines with 80 characters per line. Also, an addressable cursor and a single command screen erase were found to be necessary. The keyboard was to have a typewriter-line (QWERTY) layout with function keys and a calculator format number pad. Current system compatibility in addition to user-oriented requirements required transmission parameters to include full duplex asynchronous character-at-a-time at the rate of 1200 bits per second. A threshold for cost was set at \$1,500 when it was found that a large number of terminals possessing the required attributes existed at prices beneath this figure. Hardware acquired for the contract included Applied Digital Data Systems (ADDs) Regent 100 terminals, Timeplex 202C modems, and a Control Data Corporation 2551-1 network processing system. The CAMII language was modified to send octal values directly to the terminals, and a new operating system peripheral processor program was written to efficiently control the network processing system and transmit data between the host Cyber 7316 computer and the terminals. Eighteen application programs used by Instructors and Learning Center Managers were modified to operate on the new terminal.

*Benefits:* Low-cost terminals within project-established cost and characteristics constraints were identified, purchased, and installed. Communications equipment necessary to interface these terminals was also installed and necessary software modifications made. The use of a standard

terminal in parallel with the current AIS terminal has proven both cost-effective and desirable. The diverse needs of the various applications in a complete CMI/CAI system seem to indicate that a "mix" of terminal types will always be required. This "mix" should be considered in any future expansions of the AIS. The low-cost terminals in this study met the needs of instructors and learning center managers. Surveys taken during the test period indicated good acceptance of the terminal and the terminal system operation.

#### **Title: Operational Consequences of Literacy Gap**

*Description:* This effort, using Air Force test materials and low to medium ability Air Force personnel, attempted to determine if discrepancies between personnel reading level and material reading levels (literacy gaps) affect text comprehension over and above effects of personnel reading level alone. An additional factor studied was whether the detrimental effects of literacy gap can be overcome by allowing extra reading time. Both questions were answered affirmatively, but effects were small.

*Impact/Utilization:* The results of this study can be used as a basis for recommendations about the redesign of Air Force documents. They are defined in AFHRL-TR-79-22, *Operational Consequences of Literacy Gap*.

*Benefit:* These results suggest that before expensive measures are taken to eliminate literacy gaps by rewriting documents or allowing personnel increased reading time, the relatively small predicted gain in reader comprehension should be weighed carefully.

#### **Title: Readability of Air Force Publications**

*Description:* AFR 5-1, *Air Force Publication Management Program*, requires Air Force writers to match the reading level of their texts to that of their intended audience. The present study investigated whether rewritten regulations submitted by Air Force writers as complying with AFR 5-1 were actually comprehensible to their intended readers. The text reading grade level (RGL) for regulations in seven Air Force career fields were rechecked, and appropriate comprehension tests on these texts were given to field members. It was found that writers could not bring the RGL of their texts



down much below 11th grade, while the mean RGL of personnel in three of the seven fields was below 10th grade level. In these cases, reader comprehension scores were below the established criterion, indicating inadequate comprehension. Findings are described in AFHRL-TR-79-21, *Readability of Air Force Publications: A Criterion Referenced Evaluation*.

*Impact/Utilization:* The results of this study have been used as the basis for making recommendations and answering writers' inquiries.

*Benefits:* The results of this study have the following implications:

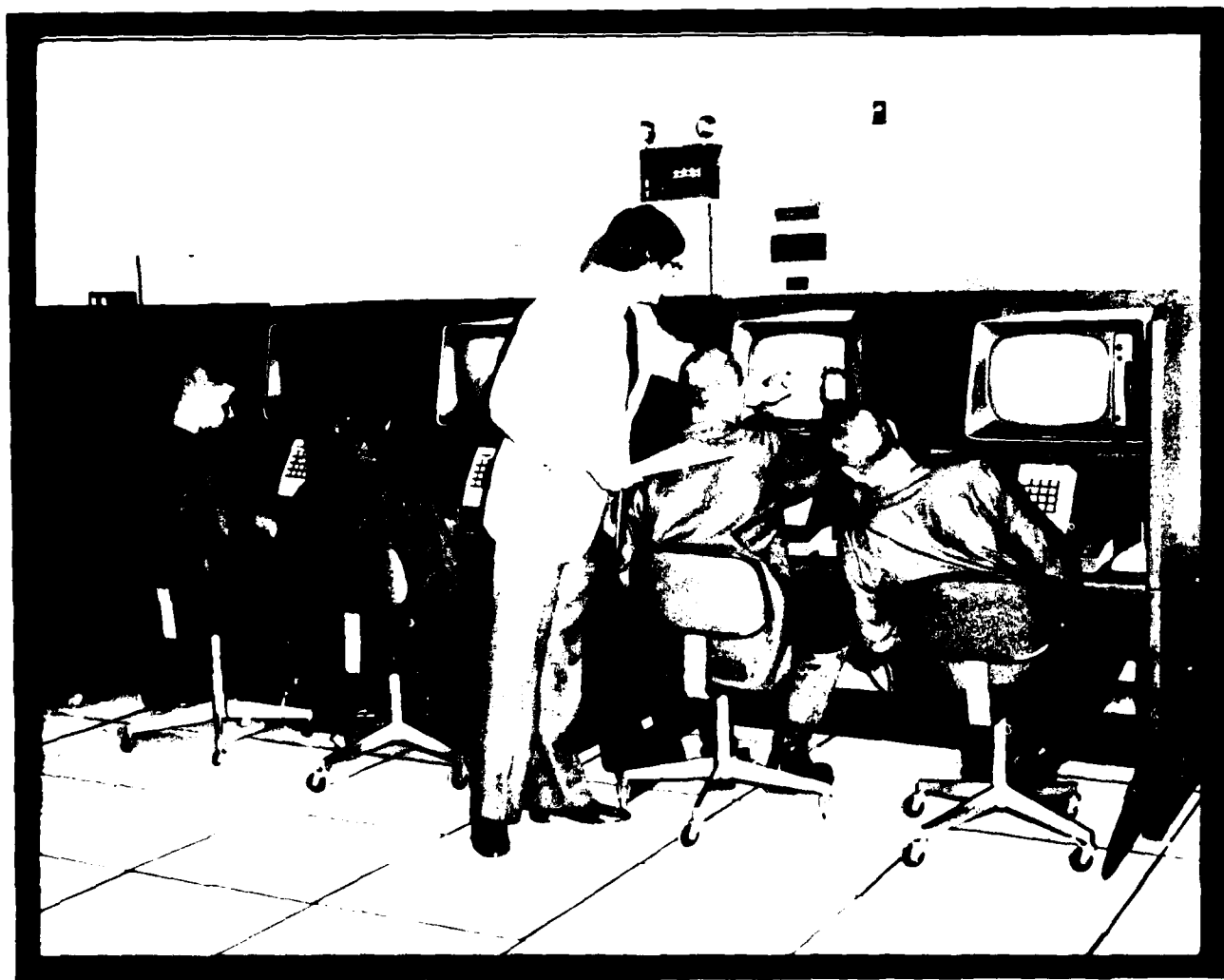
1. Writers of Air Force publications and regulations should get additional training in the use

of the FORCAST formula and in way to decrease the RGLs of their texts.

2. For the purposes of FORCAST RGL estimation, "familiar" multisyllable words should not be counted as words of one syllable.

3. The policy of writing to target audience should be continued but should not be enforced rigidly. Given the relatively crude ways employed at present to estimate literacy gap, it is probably not appropriate to insist that writers hit their targets with a great deal of precision. Additionally, the practical problems involved in simplifying materials below 10th grade level may be insurmountable. If these suggestions are followed, Air Force writers' tasks in complying with AFR 5-1 should become easier and better defined, resulting in more readable publications.

# ON-GOING RESEARCH AND DEVELOPMENT



## EDUCATION AND TRAINING TECHNOLOGY

### Title: Development of Air Force National Skills Market Model

*Description:* The advent of the all volunteer force has resulted in an expanding interest on the part of military personnel planners to understand the complex interactions between military personnel systems and various economic forces. Of specific interest are those forces which impact on individual decisions to enlist or reenlist. Even though a considerable amount of research has been completed in this area, the results have not been particularly useful. The purpose of the current research effort is to develop a computer-based national skills market model for projecting Air Force enlisted accession and retention rates under varying economic, demographic, and Air Force policy changes. The projections will include overall rates for the Air Force at large and specific rates for different levels of occupational specialty and/or quality groupings. This effort will be based upon, and will extend, a methodology developed under previous AFHRL sponsored research.

*Impact/Utilization:* This effort should refine and transition the conceptual models developed previously into a working version implemented on the AFHRL UNIVAC 1108 computer. The long-range objective of the research is to enable Air Force manpower planners to simulate the impact on Air Force accession and retention caused by changes in Air Force policies, demographic conditions and economic variables. Once acquired and implemented, the Air Force National Skills Market Model will become a general purpose tool for labor market analysis. The following organizations have been briefed on this research effort and have expressed a real need for applications of this model: Officer/Enlisted Retention (AFMPC/MPGMM), Recruiting Service (ATC/RSMY) and Airman Analysis Branch (AFMPC/MPXAA).

### Title: Development of Improved Methods for Predicting Involuntary Separation

*Description:* In response to a request for personnel research (RPR 77-14) a study was initiated in November 1977 to compare the classification accuracy of several prediction methodologies dealing with binary criteria. Included were the Motivational Attrition Prediction (MAP) method, ordinary least squares regression, standardized regression, and

Bayesian classification. During Fiscal year 1978, efforts centered on comparing the classification accuracies of the methodologies in identifying first-term airman involuntary discharges. These results were documented in AFHRL-TR-79-58, *Predicting Involuntary Separation of Enlisted Personnel*. During Fiscal Year 1979, comparisons were made using other binary criteria including graduation/elimination from technical training, basic military training, and undergraduate pilot training. A draft technical report *Evaluation of the Capabilities of Several Computerized Algorithms to Predict Graduation from Various Types of Air Force Training*, describing the results has been completed.

*Impact/Utilization:* Various Air Force agencies (such as AF/DPXOA, AFMPC/PMMA, and ATC/RSM) concerned with the problem will use the results of this research for the development of improved selection standards for initial obligated tour of duty and various types of training programs. The results could also be generalized to improve prediction in other areas of the personnel system such as promotions and retirements.

### Title: Development of On-the-Job Training Capacity Model

*Description:* As budgetary considerations force program restrictions in the Air Training Command, much of the training previously conducted in resident courses is moved into the On-the-Job Training (OJT) setting. When field supervisors become responsible for additional training over and above their operational mission, the danger exists that quality of training, mission performance, unit readiness, or all of these, may suffer. The Air Force lacks a quantifiable model for determining the relationships between these outcome variables and the amount of OJT conducted in various units. Optimum training load in OJT is being studied in this context. Attempts are being made to specify, in objectively measurable terms, the factors which impact a unit's capacity to conduct OJT without mission requirements being impaired. Training load is conceptualized as the residual when resources devoted to mission accomplishment are subtracted from total resources (i.e., manpower, equipment, etc.) available to a unit. It is hoped that more precise and measurable definitions of these factors can be formulated.

**Impact/Utilization:** When the capacity model is developed, demonstrated, and validated, Air Staff and Air Training Command managers will be able to make more objectively verifiable, data-based decisions with regard to whether a course of instruction should be taught in residence or in the OJT program.

**Title: Development of Testing and Instructional System based on Microterminal and Microfiche Devices**

**Description:** Prior research (reported in AFHRL-TR-78-50, *Development of a Low-Cost, Stand-Alone Microterminal for Support of Testing and Instruction*) showed that the use of a small, inexpensive stand-alone terminal could be used to support testing in a computer-based system such as the Advanced Instructional System. The advantage of such a terminal is both instructional and economic. Results to date indicate that the process of answering test questions using the microterminal rather than computer-readable test forms affects the speed and accuracy with which students complete a test. Over an appropriate amortization period, such as 5 years, a capital investment in low-cost terminals would effect a savings over the recurring material costs associated with test forms. The present research effort is directed toward extending the knowledge base about a new technology such as the microterminal. A basic design assumption for the microterminal was that computing power be focused on student responding rather than the presentation of information. It was felt that for most instructional purposes, the presentation of information could be as effectively handled by more traditional means of off-line presentations such as programmed texts. However, the powerful instructional technique of branching becomes difficult to implement with printed materials. For this reason, the two-dimensional accessibility feature of microfiche is seen as desirable. Additionally, in a large computer-based instructional system, the production of microfiche materials is a very direct process through the use of Computer Output Microfiche (COM). COM production techniques were studied under a just completed AFHRL effort, and the findings showed that COM was a feasible training technology. Conduct of the COM research was performed in the Weapons Mechanic Course at the Lowry Technical Training Center. The essence of the present effort is to combine the computer technology of the microterminal, which focuses on the control of student responding, and microfiche technology,

which provides ready access to diverse frame of instructional information. A hardware interface allows the microterminal to "know" which microfiche frame is being used by the student. In turn, the microterminal contains the instructional logic which directs the student through the frames of information on the microfiche. To be demonstrated at the end of this effort is a low-cost form of computer-assisted instruction and testing. In addition to the hardware development, much effort will be devoted to the pragmatics of designing and developing instructional and testing materials for the microterminal/microfiche system with an emphasis on process. The effort is directed toward designing a complete packaged system.

**Impact/Utilization:** Although the Microterminal/Microfiche System is only at the prototype stage, it is seen that fully operational units could be used in both resident and field training courses, for support of Extension Course Institute (ECI) materials, and in large-scale testing operations, such as enlistment testing. Presently, plans are being made to support block level testing in a resident course at Lowry AFB. The potential benefits of this technology are the reduction of computer form costs for computer-based instruction, provision of interactive instruction for either computer or manually managed individualized courses, reduction in instructional materials costs through utilization of micrographics technology, and increased testing capabilities, including test security.

**Title: Evaluation of Standardized Position Oriented Training System**

**Description:** In recognition of the need to devote more management attention to on-the-job training (OJT), the Air Force contracted for a large-scale systems analysis of the OJT program, which was completed in December 1975. One of the problem areas indicated by this analysis was that training tasks were not clearly defined. The most vital step in developing any training program is the identification of requirements. Unless these requirements are precisely and clearly spelled out, it is nearly impossible to develop a viable program. The Specialty Training Standard (STS), which is presently used to develop the OJT Job Proficiency Guide (JPG), in many cases is much too general to be used as a task list for OJT. It is satisfactory as a basic document for development of Career Development Courses (CDCs), technical training courses, and

Specialty Knowledge Tests (SKTs); however, it lacks the specificity required for task training. HQ USAF is experimenting with a new position-oriented approach to On-the-Job Training called SPOT (Standardized Position Oriented Training). According to present plans, occupational survey data will be used to select required tasks and identify job types. OJT will then be required for those tasks associated with the particular job type to which a trainee is assigned. AFHRL is developing new ways of organizing occupational survey data so that they can be used to design various characteristics of the SPOT system. The end product of this effort will be a set of strategies and related software for development of position specific task listings. A subsequent task will be to evaluate the strategies for extracting task listings from the occupational data base in terms of utility in the field.

*Impact/Utilization:* This effort will provide the Air Force with a method of developing clearly defined OJT training requirements for each job type within every Air Force Specialty Code. The OJT trainer will have a more definitive set of job-specific tasks with which to train and evaluate training results. The results should be a more efficient training system and a better system for tracking of training, especially for personnel after a permanent change of station.

**Title: Handbooks and Model Specifications for the Design and Development of Maintenance Simulators**

*Description:* The objective of this study is to collect, analyze, and document data in order to develop a set of introductory handbooks for Instructional System Development (ISD) teams and Training System Acquisition managers involved in requirements development, design, and procurement of maintenance simulators. In addition, this effort requires the development of model functional specifications for the design of both organizational and intermediate level maintenance training simulators for utilization in resident school and field training environments. The six-step approach that will be used involves the collection, analysis, and documentation of information on the design, fabrication, and life-cycle maintenance of maintenance simulators. This research is being conducted by a civilian contractor through a process of information requirements analysis to include (a) development of techniques and decision aids based upon an analysis of maintenance task classifications and (b) development of guidelines/handbooks and

model specifications which incorporate the preceding data collection and analysis. The ISD handbook is expected to specify procedures for (a) determining the most effective mix of training equipment (trainers primarily used by students to practice required task/part-task activities) for all types of maintenance training requirements, (b) prescribing the most appropriate design features and characteristics of maintenance simulators as a class of trainers, and (c) documenting maintenance simulator design so that it can be efficiently translated by a System Program Office (SPO) Training Device Acquisition Manager into a procurement specification with the aid of the SPO handbook.

*Impact/Utilization:* It is anticipated that the resultant documents will be use to ISD teams during the development of training specifications for maintenance simulators and to the SPO activities in the translation of these training requirements into equipment specifications in such a way that efficient and effective training devices will result.

**Title: Instructional Model for Task Oriented, Performance Based Content**

*Description:* The first and perhaps most important aspect of instructional design is the determination of what needs to be taught. Most task analysis procedures are adequate in identifying the specific task or task element but fail to give much specification to the underlying content. The present effort will attempt to synthesize factors derived from the areas of human information processing, problem-solving, cognitive structures and styles and individual differences so as to develop an instructional model for task oriented, performance based instruction. The emphasis of the model development will be the representation of knowledge through instructional content based on cognitive functioning in task specific, performance based contexts. This effort will address the issue of how to determine individual learning requirements in criterion based individualized instructional systems.

*Impact/Utilization:* Successful results from the evaluation of this model would lead to the utilization of this model for the formulation of specific procedures for conducting content analysis subsequent to task analysis in the Instructional System Development process. Better content analysis will lead to more efficient instruction through the elimination of unnecessary instruction or better sequencing of instruction.

**Title: Interservice Computerized Adaptive Performance Evaluation**

*Description:* The Air Force conducts and evaluates technical training in a criterion-referenced mode. That is to say, trainees are evaluated during training relative to a specified performance standard rather than to each other (norm-referenced). While the concept and utilization of criterion-referenced testing has been available for some time, theoretical developments have been meager due to the general popularity of norm-referenced testing. The current research effort reflects the AFHRL portion of the joint-funded, tri-service (AFHRL, Office of Naval Research, Army Research Institute) computerized adaptive performance evaluation project. The objectives of this project are (a) to develop a formal psychometric basis for the construction, development, and evaluation of criterion-referenced cognitive and performance tests, (b) to apply the psychometric foundation to the construction of item pools for criterion-referenced testing in two or more content domains, (c) to administer computerized adaptive criterion-referenced tests based, on those item pools to Air Force, Navy, and academic populations, (d) to evaluate the adequacy of the resulting test scores for both formative and summative evaluation problems with various criterion parameters, and to evaluate the adequacy of the theoretical rationale proposed, (e) to develop and refine the computerized adaptive performance simulation test, (f) to develop a taxonomy of major problem-solving modes relevant to generalized learning outcomes, and (g) to develop the psychometric methodology and integrate it with computer technology necessary to measure the major varieties of performance identified in earlier of the research.

*Impact/Utilization:* The results of this effort hold considerable promise for conducting Air Force testing more efficiently with greater precision and in considerably less time. AFHRL plans to implement a portion of the results obtained to date, i.e., adaptive achievement testing, in a technical training course at Lowry AFB.

**Title: Kalman Filter Prediction of Time Series Based on State Space Models**

*Description:* Time series analysis is a vital statistical tool in many areas of personnel research where regression analysis is not appropriate. Through a contract with Scientific Systems, Inc., AFHRL will gain the general ability to make use of

time-series prediction with state space forecasting. Prediction models will be developed for a subset of variables in the person-job-match (PJM) system and for the re-enlistment rates for selected enlisted skills. AFHRL will procure a generalized computer program for developing state space forecasting models and will hold two short courses for training analysts in state space modeling.

*Impact/Utilization:* Application of Kalman Filtering in personnel research using state space input models will greatly improve prediction accuracy in areas where regression techniques are not applicable. Kalman Filtering is a powerful estimation technique in engineering and aerospace technology. This effort will, for the first time, apply this technique to behavioral science research allowing AFHRL to expand its technical base to become the first Department of Defense organization with state space forecasting capability.

**Title: Methodology for the Identification, Development, and Evaluation of Instructional Treatments**

*Description:* The development of the Advanced Instructional System (AIS) at Lowry AFB resulted, in part, in an unparalleled operational computer-managed instruction system with the capability of implementing and evaluating instructional strategies designed to affect training outcomes. It is a common and appropriate assumption that good instruction caters to, and capitalizes on, strengths and weaknesses of the learner. To the extent that this is true, the instructional process is optimized. This optimization affects both the quality of instruction and the time required to reach mastery. The adaptive model component of the AIS was designed to permit this type of optimization; however, substantial methodological questions concerning strategy development and implementation remain. Namely, (a) the identification of instructional units for which alternate instructional strategies are potentially appropriate, and for which training time savings would be significant, (b) the identification of those cognitive skills and/or affective measures which are related to the instructional unit, (c) the translation of the identified skills into an instructional module(s) which in fact enhances performance for the identified subpopulation, and (d) the development of evaluation parameters for establishing strategy validity.

*Impact/Utilization:* The results of this research effort will be documented in a handbook appropriate

for utilization by Air Force and other Department of Defense instructional specialists for designing, implementing, and evaluating instructional strategies aimed at increasing instructional quality and reducing training time, thus reducing training costs.

**Title: Simulator Training Requirements and Effectiveness Study (STRES)**

*Description:* The basic objectives of the Simulator Training Requirements Effectiveness and Study (STRES) are to define, collect, analyze, and present data, findings, and conclusions relevant to the cost and training effectiveness of each important characteristic of aircrew training devices (ATD). To accomplish these objectives, the study has been structured around the following goals: (a) develop criteria for matching training requirements with ATD features and fidelity considerations, (b) define principles of effective and efficient utilization of the ATD within the context of total training systems, (c) develop criteria for matching instructional features and techniques with specific training requirements, and (d) identify cost factors, models, and data which influence the total cost and worth-of-ownership of ATDs. This effort is being accomplished with both contract and in-house resources and has the active participation of an advisory team composed of members of each of the Air Force major commands, the Army, and the Navy, as well as procurement and research and development agencies. Current estimated expenditure for ground-based ATDs exceeds a billion dollars over the next few fiscal years. In the current and expected climate of restricted spending, coupled with the constant requirement to maintain operational force readiness, valid information must be available to allow management and user trade-off decisions regarding training capability versus cost. In addition, such data must allow maximization of already existing devices within the inventory and currently on order. Such data may, in large measure, be provided by this study.

*Impact/Utilization:* It is anticipated that the primary users of this study will be management and operational personnel tasked with the use of ATDs to achieve and sustain operational readiness. Phase II of this study, which summarizes and presents data based on the current technical data base and operational experiences will be completed in January 1980. A series of seven technical reports documenting this effort will be published. One of these reports will contain a research plan for a follow-on phase (III) of this program. Phase III is planned as a research

activity to provide additional training information on important simulator utilization questions that cannot be answered without experimental evidence. These studies will result in specific data and recommendations pertaining to the cost and training effectiveness of various aspects of simulators to allow trade-offs to be made between desired training capability and system operation/life cycle costs. Such information can make a significant contribution to effective and efficient simulation training.

**Title: Team Training for Command/Control/Communications Operators**

*Description:* Operation of virtually all sophisticated Commands, Control, and Communication (C<sup>3</sup>) and ground-based missile systems within the Air Force requires coordination of information input, decision-making, and system output among multi-individual teams or crews. Acquisition and maintenance of team or crew skills necessary to operate C<sup>3</sup> and ground-based missile systems at high levels of proficiency are therefore essential elements in their successful implementation. This study is the initial effort in a planned R&D program whose major goal is improvement of the technology for providing team training (T<sup>2</sup>) to operators of these C<sup>3</sup> systems. This study will develop, refine, and evaluate optimal training and simulation technology along five implementing objectives. These are (a) identification and characterization of the needs for and the factors that influence C<sup>3</sup>T<sup>2</sup> programs, (b) identification of C<sup>3</sup>T<sup>2</sup> problem areas that require further research for solutions, (c) development of methods to address major problems in C<sup>3</sup>T<sup>2</sup> that can be solved with current technology, (d) application of the methods developed to operational C<sup>3</sup>T<sup>2</sup> programs for purposes of evaluation, and (e) development of recommendations regarding potential utility of simulation technology in C<sup>3</sup>T<sup>2</sup> and development of preliminary functional design characteristics of potential simulation systems.

*Impact/Utilization:* It is expected that this study will serve as one primary source of data for identification of specific training areas critical to C<sup>3</sup> system operation. These critical areas will be the subject of future efforts. The immediate impact of this effort will be development of optimal training and simulation technology to increase proficiency of C<sup>3</sup> teams with possible reduction in the costs of providing such training.

## HUMAN FACTORS TECHNOLOGY

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### Title: Computer-Based Maintenance Aids for Technicians

*Description:* The increasing complexity of Air Force weapons systems has resulted in a greatly increased need for technical data. As a result, the number of pages of technical orders required to provide technical data has increased greatly. The huge volume of technical data is overloading the already cumbersome paper-based technical order system. The problem is further compounded by the increased use of newer types of technical data, such as job guide manuals, which have been shown to improve the efficiency of maintenance personnel, but these types of technical orders require more pages. An economical, non-paper-based method for storing, updating, and distributing technical orders is urgently needed. A computer-based system has the potential for meeting this need. The objective of this project is to develop, demonstrate, test, and evaluate a prototype computer-based system to meet this need. The emphasis in developing the prototype system will be placed upon designing a system that is easy to use and that enhances the technician's performance. The prototype system will include an electronic display device (CRT/plasma), a mini-computer/micro-processor, and a storage device. Off-the-shelf components will be used. Specialized software will be developed to control the retrieval and display of the technical data. After the prototype is developed, technical data for a representative test bed system will be placed upon the prototype system. The effectiveness of the prototype will then be evaluated by measuring the performance of technicians using data presented by the prototype system to maintain the test bed system. The study will evaluate the feasibility and desirability of an automated technical order system and will define the requirements for an effective system.

*Impact/Utilization:* The prototype system, specifications, and lessons learned in the evaluation will be used by the Air Force Logistics Command in the development of the computer-based technical order system for operational use throughout the Air Force. This program will contribute to reducing the cost of maintaining weapons systems by improving the efficiency of Air Force maintenance technicians and by reducing the cost of maintaining the Air Force technical order system.

### Title: Human Resources in Weapon System Acquisition

*Description:* The purpose of this project is to provide a technology capable of predicting, early in the weapon system acquisition cycle, the life cycle cost/human resource/system support impacts of alternative weapon system designs and support concepts. In the past, weapon systems have been designed with little attention devoted to support of the system in the field, largely because little definitive information was available early in the system design as to the effects of alternative designs on system supportability. With the costs of system operation and support approaching 80% of the life cycle costs in some systems and with the costs of the human resources associated with the weapon system being approximately 50% of the systems life cycle costs, designers must be provided with the information necessary to control life cycle costs through the design of the weapon system. This will be accomplished by integrating, validating, and demonstrating a number of techniques, separately developed and validated by AFHRL, into an integrated technology for planning the human resource element of a weapon system. The resulting integrated technology will provide timely feedback of the life cycle costs of alternative weapon systems designs early enough in the acquisition cycle to provide decision-makers the opportunity to consider human resources life cycle costs in the design of weapon systems. The approach is to integrate, apply, and test the technologies that AFHRL has developed in the areas of (a) including human resources and personnel costs as parameters in design studies, (b) forecasting and controlling manpower requirements through the application of systems analysis and computer modeling techniques, (c) improved technical data for maintenance personnel, (d) training requirements analysis and advanced training techniques, and (e) system ownership costing. The project is conducted in close cooperation with the System Program Office for the Advanced Medium Short Takeoff and Landing Transport and with the Aeronautical Systems Division Deputy for Avionics Control, Air Force Systems Command.

*Impact/Utilization:* This research should have a significant impact on the methods used to design, and



on the actual design of future weapon systems. It will also affect the weapon system development approval cycle, as different information requirements and trade-off study results will be required for system approval to proceed at major Defense Systems Acquisition Review Council reviews. The results of this research can be used by System Program Offices, Air Logistics Centers, weapon system contractors, and others involved in the design and major modification of weapon systems.

**Title: Logistics and Human Resources Data Base**

*Description:* A computerized logistics and human resources (HR) unified data base (UDB) will be developed to support the weapon system (WS) design process. Examples of logistics and HR data are maintainability (crew size, repair time, skill level, shift manning); maintenance tasks (calibrate, remove and replace, adjust/align, troubleshoot, test/inspect); reliability (mean flying hours and/or sorties and/or ground time between failures and/or maintenance actions); support equipment requirements (test equipment, tools, jigs, auxiliary power).

*Impact/Utilization:* Consistent utilization of the UDB by the Aeronautical System Division, the Air Force Test and Evaluation Center, the Air Force Acquisition Logistics Division, and the aerospace companies will assure that the logistics and HR data being used are consistent throughout the life of the WS. Also, the UDB will make logistics and HR data available to the designers, managers, logisticians, and engineers at an earlier stage of the WS design process. This will allow logistics and HR factors to impact design to a much larger degree. Significantly reduced logistics and HR costs throughout the WS life should result.

**Title: Identification and Analysis of Factors Influencing the Performance of Air Force Maintenance**

*Description:* Certain conditions facing the nation today are being felt severely in the performance of duties in the Air Force aircraft and missile maintenance career fields. Inflation, high personnel costs, technological advances, personnel turnovers and reductions, and the basic capabilities of the new Air Force recruits have combined to severely impact the performance of maintenance jobs. Although maintenance consumes nearly 25% of all Air Force manpower and nearly 50% of the Air Force budget, few research dollars are being spent to improve the

actual accomplishment of maintenance. Further, no real basis exists for developing a maintenance research program, because the factors which impact maintenance performance are not known. This new research effort will identify the factors which influence maintenance performance in both aircraft and missiles. The interrelationship among and between factors will be prioritized in terms of the greatest impact on performance. Another phase of the program will develop a long range maintenance research plan, based upon the factors having the greatest impact upon performance. Another product will be a plan to apply existing technology to help alleviate known problems. Data will be collected via individual interviews and questionnaires at a variety of Air Force bases and at all levels of maintenance from technicians, supervisors, and managers. Separate research programs will result from the long range research plan.

*Utilization:* The results of this research will be used by research personnel to build specific research programs to improve maintenance. Information resulting from the research is also expected to be used by maintenance managers at all levels of command to influence policy decisions.

*Benefits:* The Air Force is expected to increase both the efficiency and the effectiveness of its maintenance personnel in aircraft and missiles as a direct result of this research. The long range maintenance research plan resulting from this research will guide the allocation of limited research dollars into the areas where payoffs are most likely and improvement most required. The end result will be improvement in the effectiveness of maintenance personnel, the efficiency of the work force, the nature of the maintenance environment, the acceptability of maintenance as a career, and the overall readiness of the aircraft and missile forces.

**Title: Writer's Aid Computer Program**

*Description:* This effort will produce a FORTRAN program which accepts, as input, text typed into a computer and outputs a variety of information useful to writers and others concerned with the readability of Air Force documents. The program is designed specifically for Air Force tests and provides four readability estimates, three of which were validated on military material, as well as text parameters (e.g., mean words per sentence). The program will additionally print out "problem aspects" (e.g., overly long sentences) of a given text and will automatically generate CLOZE comprehension tests so that

formula estimates can be supplemented with the actual comprehension scores of personnel. Additional features will be added as suggested.

*Impact/Utilization:* This program will enable the automated evaluation of the texts of Air Force writers who are complying with AFB 5-1, *Air Force*

*Publications Management Program* and will allow writers to train themselves to create more readable and comprehensible tests. It is seen as particularly useful to writers of regulations and to curriculum developers.

## MANPOWER AND PERSONNEL MANAGEMENT TECHNOLOGY

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### Title: Development of Maintenance Metrics

*Description:* The manpower and other resource requirements essential to the Operations and Maintenance (O&M) of a weapon system have been determined using the traditional "flying hours" and "sortie rate" measures. The deficiencies of these traditional measures are well known and such measures frequently are found to be totally irrelevant. For example maintenance on a gun subsystem is generated by factors like the number of rounds fired and is not affected by the number of flying hours or sorties. These traditional measures are also insensitive to variations in operations and environmental conditions. The present difficulties then lie in the fact that the currently used metrics do not consider the inherent differences between the individual subsystems of a weapon system and are totally insensitive to operational and environmental conditions.

The objective then is to determine the hardware, operations and environmental parameters which are necessary and sufficient to identify the drivers of maintenance demands for a weapon system, and to develop more accurate metrics and weightings to be incorporated into the Air Force method (Logistics Composite Model) of determining manpower and other resource requirements for operational and developing weapon systems.

*Impact/Utilization:* The maintenance metrics that are developed will provide a method for measuring and predicting the functional relationship between the maintenance demands and the hardware, operations, and environment of a developing aircraft system. The metrics when used within LCOM will provide the Air Force with a powerful tool to aid trade-off decisions from conception through the operational life of any Air Force aircraft system.

### Title: Development of Policy Analysis Model for the Air Force Logistics System

*Description:* The policy analysis model is designed for use in policy development and in resource control. It is designed to enhance the understanding of the overall impact of the policies established by senior management upon the very complex logistics system. Simultaneously, it provides a means to evaluate the effects of these policies. The first phase of this effort has been completed and consisted of the development of a conceptual model of the Air Force Logistics System by means of extensive interviews conducted through the logistics community. The results of these interviews allows the researchers to define and gain comprehensive understanding of the system, its organization, functions, and interactions among its various principal components. The Air Force Logistics System is a classic information feedback structure. The approach of the on-going research is to decompose this structure in a series of steps based on system conceptualization, analysis, and measurements.

*Impact/Utilization:* The conceptual model developed through this exploratory research will be the basis of policy development and resource control by senior Air Force managers within the logistics community.

### Title: Evaluation of Resource Trade-Off and Allocation Methodologies

*Description:* Efficiency and appropriation of mathematical and statistical methodologies applicable in decision-making processes are being compared. In particular, single- and multi-attribute utility and value function algorithms, judgment analysis, and policy-specifying are being examined for their relative usefulness and applicability for

decision-making processes when the possible alternatives are uncertain and for which the goals and objectives of the decision environment are in conflict. Resources in the research and development area and the personnel assignment area are being used as the decision environment in comparing the various methodologies.

*Impact/Utilization:* The results will provide Air Force personnel managers with better tools to assist in making decisions regarding personnel selection and resource utilization.

#### **Title: Functional Literacy Task Inventory**

*Description:* Although the Air Force has been much concerned with the problem of making sure that the literacy demands of a career field are not beyond the capacity of personnel assigned to that field, no study has been performed to determine precisely what these demands are for different jobs. The consequences of a mismatch between job reading demands and personnel reading ability have also not been determined. The present effort represents the first step in the attempt to obtain answers to these questions. By means of successive cycles of tryout, data analysis, and survey instrument refinement, a methodology for the task analysis of job-related literacy tasks is being developed.

*Impact/Utilization:* The eventual product of this effort will be a field-tested survey instrument for use within the framework of the Air Force occupational survey system. The administration of this survey will allow the characterization and clustering of Air Force jobs in terms of their literacy task demands. This information should ultimately lead to more job-specific, job-relevant reading improvement training, more precise and cost-effective personnel assignment, and better design of Air Force documents.

#### **Title: Historical Data Base of Enlisted Personnel by Cohort Year Group**

*Description:* The primary objective of the Cohort Data Base is to support loss/reenlistment/extension analyses requirements/trends by fiscal year of accession. This data base has been developed covering accessions and associated loss/reenlistment/extension transactions for the time period FY70-FY78. Statistical tables which have been prepared using this data base reflect (a) percentage of total lost (within each type of loss category), (b) percentage of loss from accessed population at the beginning of a

year to cover a 10-year period, (c) cumulative percentage of loss, (d) percentage of those lost in Basic Military Training (BMT) by type of loss category, (e) percentage of those lost subsequent to BMT by type of loss category, (f) total percentage of extending population, (g) percentage of beginning population who have extended and are on extension, (h) percentage reenlisting, (i) percentage reenlisting with/without bonus, (j) percentage reenlisting with less/with more than 90 days to Expiration of Term of Service, and (k) percentage of losses eligible/not eligible to reenlist. Statistical summary tables to provide quick reference to the number of individuals accessed in each fiscal year also show the (a) number lost, (b) loss rate, (c) retention rate, (d) continuation rate, (e) number reenlisted, and (f) reenlistment rate. These counts and percentages are reported for each of the 10 fiscal years covered by the report.

*Impact/Utilization:* These reports will be used to (a) track enlisted retention by cohort year groups (b) relate enlisted retention/reenlistment/losses to personnel program objectives, and (c) analyze the retention/reenlistment/losses of cohort year groups by various demographic attributes, such as, sex, race, academic education level, Armed Forces Qualification Test group category, term of enlistment, age at accession, number of dependents, and marital status. These reports will be used by Personnel Systems managers at HQ USAF, the Military Personnel System, and the Office of the Secretary of Defense.

#### **Title: Integrated Simulation Evaluation Model**

*Description:* The Integrated Simulation Evaluation Model (ISEM) is an AFHRL effort to develop a total system simulation model of the Air Force manpower and personnel system, including active duty and reserve military forces and civilian employees. ISEM departs from most other manpower personnel modeling efforts in its emphasis on the Air Force manpower and personnel system as a single, unified, integrated system which procures and translates human assets into mission capabilities. The total system orientation constitutes the basis for development of ISEM as a large-scale simulation model which integrates subsystems across functional specialties and evaluates performance of total system effectiveness and efficiency.

*Impact/Utilization:* ISEM will be used to provide decision-makers with information of a fundamentally different type. This information is different in that it systematically incorporates the

total system perspective into high-level policy analysis. With today's policy analysis tools, understanding the total system impact of policy options is very difficult. ISEM would make this important requirement much more attainable by providing a generalized capability for analyzing how policy interacts with all the elements of the system (manpower, personnel, and training) to affect (a) mission capabilities, (b) costs, and (c) the efficiency

with which the system operates. ISEM will provide the decision-maker with improved information for understanding the total system impact of policy options. This will provide the senior decision-maker with a substantially improved basis for resolving many important high-level policy issues within the Air Force manpower and personnel system and with an improved rationale for justifying policy.

## TRAINING DEVICES AND SIMULATION TECHNOLOGY

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### **Title: Advanced Simulator for Pilot Training (ASPT) Alternate Display**

*Description:* The cathode ray tubes (CRTs) used for the Advanced Simulator for Pilot Training (ASPT) are rapidly approaching their projected life span. Sixteen replacement CRTs will be required within the next 24 months; necessitating a combined refurbishment and new CRT production rate which exceeds past performance of the CRT vendor. An attempt to alleviate this situation will be investigated by replacing one of the present CRT assemblies with a 1000-line light valve projector, lens, and rear screen assembly.

*Impact:* One channel of the ASPT display will be replaced with a light valve projector in order to assess its performance, maintainability, and reliability. If it is successful, the light valve projector will provide the ASPT display system with one alternate source which should be more readily available and reliable on a competitive basis. This would also provide additional reliability and maintenance data for similar projects.

### **Title: Advanced Simulator for Pilot Training Multiple Moving Model Engineering Development**

*Description:* In its original configuration, the Advanced Simulator for Pilot Training (ASPT) computer-image-generated visual system provided one moving model for each of the two cockpit displays. For purposes of undergraduate pilot training research, this was adequate. However, with the expansion of research into the tactical research arena, additional moving models are required to visually simulate dynamic hostile environments. The purpose of this modification is to provide up to seven

moving models to be shared among the two ASPT modular cockpit displays.

*Impact:* The additional visual moving model capacity will be used to visually simulate moving ground targets, friendly and enemy aircraft, surface-to-air missiles, aircraft rocket fire, and other moving features indigenous to hostile environments. This capability enables behavioral research to assess moving model requirements for tactical simulation, development of simulator training syllabuses, and generation of air combat tactics.

### **Title: Assessment of Avionics Management in F-15 Dissimilar Air Combat Training**

*Description:* F-15 pilot performances in the multi-bogie air combat environment have indicated inadequate acquisition and retention of skills necessary to achieve satisfactory levels of combat readiness. The initial portion of an aerial engagement (i.e., beyond visual range) has been identified as a problem area. This portion of the engagement involves the use of avionics in acquiring, identifying, and prioritizing the targets. Currently, training for this portion of the engagement is minimal. The training problems are compounded by the lack of performance measurement for use in evaluation and instruction. Simulator software has been developed for training the beyond-visual-range segments of dissimilar aerial combat. The simulator scenarios provide realistic radar target maneuvering. The training will be used in conjunction with a performance measurement system developed for application in both simulator and aircraft engagements. The simulator training and performance measurement will be validated during aggressor squadron engagements.

*Impact:* The results of this effort can be extended to other weapons systems and applied during formal and continuation training to increase proficiency in dissimilar aerial combat.

**Title: A-10 Training and Research Engineering Development (ASPT)**

*Description:* Phase I of the Advanced Simulator for Pilot Training (ASPT) A-10 Project consisted of modifying cockpit "A" of the ASPT from a T-37 to an A-10 configuration. The modification provided conversion and tactical weapons delivery training for the Tactical Air Command (TAC) and the ability for AFHRL to conduct training research. Phase II will provide advanced conversion, manual reversion, and hostile tactics research and training. The Phase II cockpit of A-10 is an in-house, modular design and is capable of being used for research studies not directly connected with A-10 aircraft nor TAC training. Research performed this year included motion/force cueing studies in the ASPT using A-10 student pilot subjects in conversion and air-to-surface training. Proposed activities include studies of the Inertial Navigation System (INS) heads-up display symbologies for the A-10 aircraft, level-of-detail of computer image generation (CIG) required for a KC-135 tanker model to accomplish air refueling training, and tactics used for low-level flight in a high threat environment. Continuing engineering research and development includes the completion of the modular A-10 cockpit to fly in the Manual Reversion Flight Control System mode and expanded simulated hostile environments.

*Impact:* The "A" cockpit of the ASPT, presently in a modular A-10 cockpit configuration, will be used for TAC A-10 training until the delivery of A-10 simulators to TAC. It will also be used for research on high-threat environment tactics. By providing a research tool for simulated hostile environment studies visual display requirements, force cueing, and advanced instructional methods, ASPT A-10 simulation provides the Air Force with a valuable flying training research tool. This simulation also provides TAC with a unique opportunity to acquire valuable simulation training during research studies.

**Title: Design and Delivery of Flat-Panel 6883 Simulator for Comparison with Three-Dimensional Maintenance Simulator**

*Description:* The objective is to develop a flat-panel simulation of the 6883 Converter/Flight Controls Test Station associated with Intermediate-

Level maintenance of the F-111 aircraft. The simulator will subsequently be used in studies of the impact of psychological fidelity inherent in real equipment, three-dimensional simulators flat-panel simulators and graphics simulations on technical training and subsequent job performance. The civilian contractor will design a flat-panel simulator providing comparable training capability to the three-dimensional simulator previously developed. To maximize comparisons between the two simulators, parameters will be contrasted insofar as practical. Initial areas where contrasts appear to be feasible are (a) physical fidelity, (b) minicomputer vs. microprocessor control, (c) FORTRAN programming vs. an ATLAS-like language, (d) degree of integration with theory portions of course, (e) environmental requirements, (f) indigenous vs. adjunctive knowledge of results, (g) relative emphasis on procedures and system logic, (h) degree of performance monitoring, and (i) efficacy of stand-alone part-task trainers associated with the simulator.

*Impact/Utilization:* This research will result in a flat-panel simulator and the associated documentation required update and modification of the simulator. The simulator will be utilized in subsequent investigations of the impact of physical fidelity on training in an effort to ascertain degree of realism required for cost-effective training. Results bear promise of having utility in the development of future trainer requirements and specifications. These results will be meaningful both in terms of developing training programs for new weapon systems such as the MX missile, and also for improving training on existing systems. One area of particular interest is the impact of lowered fidelity on the time required to develop and implement new training programs.

**Title: F-16 Research Program**

*Description:* The introduction of the multi-role F-16 aircraft into the Air Force inventory will greatly increase pilot training requirements. Learning to master air-to-air or air-to-surface combat skills is a difficult and demanding task, but when piloting skills are necessary in both, the additional training load is significant. Furthermore, the F-16 incorporates advanced technologies (e.g., fly-by-wire control, a high "g" and high visibility cockpit, a digital computer system for heads-up display and avionics, etc.) that will make initial and transition combat crew training a difficult job. Even the experienced pilot will have little familiarity with the instruments and controls used in the F-16. The F-16 weapons

system with its many unique design features and dual combat role raises a plethora of novel training research issues. There is a general consensus that the two major psychological components of piloting ability are cognitive and perceptual-motor skills. In the F-16 weapons system, training skills in each of these two components takes on new dimensions. The selection of weapons, the interpretation of fire control displays, and the tactical employment of the aircraft all involve cognitive elements in behavior. With the fly-by-wire system, the control of the F-16 also becomes a critical factor in training. How quickly can the novice pilot adapt to this system? What relearning problems face the transitioning pilot? Finally, does the high visibility cockpit, with its dearth of aircraft-referenced cues, pose difficulty for the pilot in close-to-the-earth maneuvers? An F-16 training research program using the Advanced Simulator for Pilot Training (ASPT) has been developed as a result of a significant delay between delivery of the F-16 aircraft and subsequent availability of its flight simulator. The F-16 Operational Flight Trainer will not be available until Summer 1980, and the Full Mission Simulator (FMS) will probably not be in service until 1984 or later. The ASPT/F-16 training research program will enable pilots entering F-16 training to receive simulator training and will also give psychologists the opportunity to research advanced fighter simulation systems. The two core components, i.e., cognition and perceptual-motor control, reappear throughout the F-16 training research spectrum. They are driving factors in simulator design, training media mix, syllabus development, and performance measurement. The advanced concepts employed in the F-16 design must be matched by equally advanced concepts in the F-16 training domain. Since the potential of the F-16 is so great, every effort must be made to exploit its capabilities through optimum training.

**Impact:** Since the Tactical Air Command training requirement materialized in 1979, a gap has existed between training requirements and training capability. The ASPT research program will satisfy a real operational need in addition to building an advanced aircraft Research and Development data base. This data base will be used for determining F-16 FMS design configuration, and it will also provide a cornerstone for training research dealing with advanced technology aircraft.

#### **Title: F-16 Simulation Engineering Development on the Advanced Simulator for Pilot Training**

**Description:** On 25 September 1979, AFHRL achieved a new milestone as the first group of subjects for the F-16 training/research, completed their training in the Advanced Simulator for Pilot Training (ASPT). This group consisted of future North Atlantic Treaty Organization (NATO) F-16 instructor pilots. This activity followed a year-long, intensive, in-house engineering effort which resulted in major changes to the Advanced Simulator for Pilot Training (ASPT) system. Included was the integration of a distributive processor system, replacing the single computational system used to simulate the T-37. The "B" side T-37 cockpit was replaced with a modular F-16 cockpit to allow for initial air-to-surface tactical research. A major software effort was required to duplicate performance and handling qualities of the F-16. Special efforts were needed to accommodate the neutrally stable aircraft and to duplicate the aircraft analog flight control computer. Engine simulation was also challenging as the F-100 is a very sophisticated engine using a combination of mechanical and electrical controls. One of the outstanding in-house engineering achievements was in the simulation of the F-16 state-of-the-art avionics network. Using an actual aircraft head-up display (HUD), stores control panel (SCP), fire control navigation panel (FCNP), side arm controller, and throttle grips, engineering personnel achieved a virtual duplication of the sophisticated air-to-surface delivery modes of the F-16. This involved considerable software development to duplicate the aircraft fire control computer. In addition, special computer interfaces were developed to drive the SCP and to allow the ASPT general purpose computer to transmit data over a simulated aircraft multiplex bus to the HUD and FCNP. To support research requirements, completely new performance measurement schemes and data record schemes were developed. As research continues, these will be refined to provide the most comprehensive, quantitative data on weapons delivery. The revised ASPT system allows for the beginning of a new era in simulation research.

**Impact:** The ASPT F-16 will be used by the Tactical Air Command and by the Air Force Systems Command to conduct valuable research on the use of

wide-field-of-view (WFOV) simulators for training tactical tasks. This simulation should further demonstrate utility of WFOV visual systems for training tactical maneuvers in conventional and hostile environments and provide a research device for evaluation of simulated hostile environments, force cueing schemes, and advanced instrumental methods. TAC will also have an interim simulator capability for F-16 pilot training.

**Title: Implementation of a Helmet Mounted Sensor/Helmet Mounted Display on the Advanced Simulator for Pilot Training**

*Description:* AFHRL is in the process of integrating state-of-the-art equipment with the Advanced Simulator for Pilot Training (ASPT) as a follow-on to the engineering feasibility demonstration of the helmet-mounted sensing and display equipment borrowed from the Aerospace Medical Research Laboratory. The new helmet-mounted sensor (HMS) utilizes an electromagnetic field detector rather than an infrared detector and provides X, Y, Z (roll, pitch, and yaw) data. This information is supplied to a greater degree of accuracy for a wider range of helmet motion, compared to the previous equipment. The HMS/helmet-mounted display (HMD) will be implemented in both ASPT cockpits. The HMD consist of a small cathode ray tube (CRT) mounted on the side of the pilot's helmet, projecting a display on a combining glass in front of the pilot's eye. This system presents either a high resolution range (less than 1 to 3 arc minute) monocular (right or left eye) central vision area (1 to 40 degree field of view (FOV)) display, or two units may be combined to provide binocular coverage in conjunction with the ASPT full FOV display. The HMD collimated image is at the same focal distance as the background ASPT wraparound display and will be optically combined with the background which is observable with both eyes. The system also allows unconstrained pilot movement within the cockpit and will provide a correct image perspective with occlusion by the pilot's aircraft.

*Impact:* Installation of the HMS equipment will provide the capability to utilize the ASPT in pilot workload, head-in cockpit, head vs. aircraft attitude, and visual FOV studies. The addition of HMDs in both ASPT cockpits will vastly expand the research potential to include key issues in visual flight simulation. Studies may be conducted to determine resolution, scene detail, and FOV requirements for

various flying tasks. HMDs may be evaluated for their training potential in air combat maneuvering, air combat tactics, stand-off weapons systems, and associated tactics. Evaluation may also be performed on fly-by-sensor system display, Maverick missile helmet displays, and helmet display of aircraft data. With the F-16 and A-10 cockpits, studies could also be performed to develop F-16 and A-10 tactics training scenarios. The findings from studies using this equipment should be very useful in designing specifications for future flight simulators having the potential of resulting in considerable dollar savings, reduced training time, enhanced operational readiness, and increased capabilities and training effectiveness.

**Title: Operational Test and Evaluation Handbook for Aircrew Training Devices**

*Description:* The Air Force plans extensive simulator procurements in order to maintain operational readiness and reduce training costs. These simulators will be employed across the entire flight training spectrum, beginning with undergraduate pilot training, continuing through combat crew training, and culminating in the maintenance of proficiency in aircrew skills. The critical requirement is that these simulators provide a training medium that enhances aircrew quality while using fewer resources than would be consumed by the aircraft. Since significant Department of Defense investments depend on the capabilities of these simulators, their training effectiveness must be thoroughly and accurately evaluated. Although the Air Force plans to conduct a series of tests and evaluations on these devices, the methodologies and techniques by which these are to be accomplished have not been determined. What can be stated with certainty is that a multidisciplinary approach will be required. At a minimum, thorough tests and evaluations will include considerations of training capabilities and transfer, media utilization, human engineering, device reliability and maintainability, and life-cycle costs. As a consequence, knowledge from the fields of psychology, education, engineering, and economics must be combined to provide a cohesive approach. Consequently, a handbook is required that will

1. Determine appropriate methodologies that can be utilized as standards for assessing simulator training effectiveness. The major elements of this effort will include:

a. Application of alternate definitions of training effectiveness suitable for various systems.

b. Selection of measures and techniques that will validly and reliably evaluate levels of individual task performance for both student and instructor/operator personnel. This activity will consider such items as appropriate statistical analyses, sample sizes, sample representativeness, and training criteria selection.

c. Investigation of student/instructor/operator/training manager attitudes and their impact on simulator acceptance, utilization, and confidence in the training program.

d. Investigation of the relationship between system availability and reliability and the capability to maintain the intended training program.

2. Determine appropriate techniques to evaluate system control features such as the instructor/operator console; adaptive training provisions; system operability; and special system training capabilities, for example, freeze, reset, automated playback and prerecorded demonstrations.

3. Determine the appropriate composition of the Operational Test and Evaluation Team in terms of disciplinary skills and experience.

4. Identify the resources necessary to conduct operational tests and evaluations in terms of personnel, hardware and software considerations.

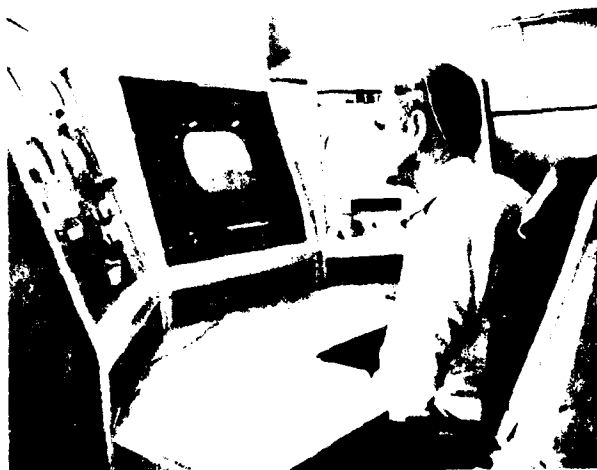
*Impact:* The research results will (a) provide Air Force leadership with direction in making sound decisions in allocating huge expenditures on aircrew simulators and (b) provide the operational Air Force units proper methodology in the planning and conduct of aircrew simulator test and evaluation programs for a variety of systems.

#### **Title: Psychological Aspects of Sensor Simulation**

*Description:* The objective of this program is to determine the features of operational sensor displays that must be emulated with computer-generated imagery (CGI) for effective training of aircrews. Systems such as the Forward Looking Infrared (FLIR) and Low Light Level Television (LLTV) sensors increase the terrain avoidance capability of the B-52 during weather penetrations and night flying. These sensors, however, result in formidable problems for the development of effective training devices. First, the quality of the image presented to the operator by the FLIR sensor is dependent on such factors as the thermal emissivity of ground objects and their surround, sun angle, meteorological conditions, and season of the year. Second, the flight profiles that must be simulated for training require that large gaming areas be represented for long range missions. These problems cannot be solved with

terrain model boards. Under related programs, efforts are underway to develop the technology of using computers to emulate FLIR and LLTV images. The cost of such computer-based systems, however, is influenced by the degree of detail in the synthetic image. Accordingly, the purpose of this program is to determine how much fidelity and realism are required to produce adequate training of sensor operators. The objectives are being pursued from several research avenues. First, analytical and empirical investigations are being carried out to determine what features of the sensor images influence performance during terrain avoidance flying, navigation update, obstacle detection, and damage assessment/strike and how these features can be emulated with CGI. These studies include procedures that compare real-world imagery obtained from B-52 sorties with the emulation of the same images. Second, terrain and cultural features, meteorological factors, and other environmental variables are being studied for their potential effect on the flying tasks mentioned above. Various methods for emulating the physical properties of the scenes with CGI are investigated. The resulting images are then assessed to determine the level of fidelity required in the scene to accomplish effective training.

*Impact/Utilization:* This research should have a significant impact on current and future work dealing with computer generated imagery for sensor simulation. More specifically, it will identify the amount of fidelity needed for adequate training of sensor operators. The results can be used by organizations such as the Simulator Systems Program Office as well as by other agencies and individuals that carry out research and development on CGI for training.



Operator Station for Assessment of Computer-Generated Imagery.

#### **Title: Simulator for Air-to-Air Combat—Advanced Simulator for Pilot Training Interface**

*Description:* A low cost, low priority



demonstration project is being implemented to show that two simulators at widely separated geographical locations can be used in an interactive mode for air-to-air combat, aerial refueling, and various tactical scenarios. The devices to be used are the Simulator for Air-to-Air Combat (SAAC) and the Advanced Simulator for Pilot Training (ASPT). The SAAC is installed at Luke AFB, approximately 30 miles west of Phoenix; the ASPT is installed at Williams AFB, approximately 30 miles east of Phoenix. SAAC is comprised of two F-4 cockpits mounted on synergistic six degrees-of-freedom motion systems. Each cockpit is enclosed by eight cathode ray tubes (CRTs) and collimating windows displaying the visual scene and affording the pilot a nearly unlimited field of view. The visual display is provided by an electronic synthetic terrain generator and a camera model aircraft image generator. Each pilot is furnished a representation of the maneuvering of the adversary aircraft. G-seats and g-suits provide vibration cues to supplement those from the motion system. The gunfire trajectories and missile trajectories are computed so that the scoring system can accurately assess hits during simulated engagements. The ASPT is capable of simulating a variety of aircraft, including the A-10, F-16, B-52, and T-37. Each cockpit in the ASPT is enclosed within a seven-channel visual display subsystem. The system is presently configured as an A-10 aircraft on cockpit "A" and as an F-16 aircraft on cockpit "B." Various incompatibilities existing between the two systems had to be overcome; for example, the SAAC operates at an iteration rate of 20 times a second, whereas the ASPT has a rate of 30 times a second. The most inexpensive manner of integrating these two computer-controlled systems was through dedicated land lines leased from the telephone company. After considerable in-house engineering effort, the system was made acceptable. The specifications for the ASPT-SAAC tie-in were completed 1 March 1979, and the first engineering demonstration was conducted 14 October 1979.

**Impact:** The following capabilities were demonstrated. (a) Both simulators can be preset to a common initialization point using predetermined displacements. (b) The pilot in the SAAC can observe the ASPT pilot maneuvering, appearing as a MIG-21. (c) Simultaneously, the pilot in the ASPT observes the SAAC pilot maneuvering, also represented by a MIG-21 moving model. (d) The pilots are free to perform any required change in attitude or power necessary in a real-world situation to obtain a "kill." (e) Each system independently determines whether its pilot has been successful in

causing the destruction of the other participant. (f) A confirming message from the winning system computer informs the losing system computer of the kill. (g) At this point, both systems freeze in the condition existing when the victim was terminated. (h) This system has demonstrated that it is feasible to interface modern simulators which are physically remote from each other. (i) The application of this principle with utilization of military satellites for data relay will allow an entire new spectrum of simulator usage, greatly expanding the usefulness of simulators in improving the skill of operational aircrews.

#### **Title: Summative Evaluation of Three-Dimensional and Two-Dimensional Simulators for Maintenance Training**

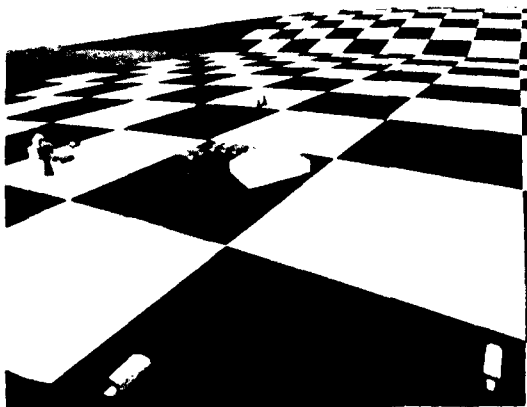
**Description:** To provide competent maintenance technicians to the field, expensive actual equipment is customarily employed during training. However, actual equipment neither possesses the capability to induce malfunctions nor tests the delayed consequences of malfunctions upon systems performance for training purposes. Less expensive real-time simulators do possess the capability for practical training, incorporating hands-on practice to increase troubleshooting skills on samples of field-related maintenance problems. In addition to improved skills training, properly designed computer-based training simulators also have the potential to release more expensive actual equipment to the field. Major objectives of this evaluation are to comparatively assess two simulators (three dimensional (3D) and two dimensional (2D)) and actual equipment on instructional cost-benefit, and additunal dimensions within an operational Air Training Command course.

**Impact/Utilization:** Comparative data are currently being gathered on the 3D simulator and actual equipment. Although preliminary pilot data indicate no significant differences in achievement, this is largely due to the lack of adequate training time (2-1/2 days) and sensitive measures of objective criterion performance. Efforts are underway to develop alternative objective measures of performance and adequate training time extension. Acquisition data cost comparisons reveal the 3D simulator is 60% less costly than the actual equipment. Hence, if simulators were found to be at least as effective as actual equipment, then simulators might profitably be deployed throughout entire maintenance training courses.

**Title: Visual Cue Requirements for Terrain Flight Simulation**

**Description:** The lack of adequate visual scene detail is often considered to be a limiting factor in the use of computer-generated imagery for terrain flight. Terrain flight is an important means of survival in the face of the enemy and it includes low level, contour and nap-of-the-earth flight at successively closer approaches to the ground. In such close proximity to the ground, a great deal of visual detail is available to pilots, far more detail than it is currently feasible to simulate with computer-image generation (CIG) systems. This research study has developed a special visual environment which allows us to maximize the CIG visual cues within a limited area. During the study, the types of visual cues available to the pilots will be varied in order to identify, by pilot performance measurement, the cues that are most important for terrain flight simulation.

**Impact:** This study is the first in a series of efforts to develop suitable visual cues for training terrain flying. This critical flight skill is quite hazardous to perform in actual aircraft, thus making flight simulation a particularly important alternative form of flying training. This particular study should be especially useful because it seeks to implement simulation training using CIG hardware which is already operating. Thus, it will not require the development of new hardware techniques before it can be implemented in other flight simulators using CIG visual displays.



**Nap-of-the-Earth Simulation.**

**Title: 6883 Maintenance Training Simulator Development Utilizing Imagery Techniques**

**Description:** The purpose of this exploratory study is to evaluate the feasibility and training effectiveness of an imagery technique known as Imagetics. The technique uses visual imagery to enhance learning. The imagetics technique is a novel method for determining the extent or effectiveness of an individual's complete mental picture of some previously memorized graphical matter. To use the technique, the subject graphically reproduces portions of the previously memorized matter, e.g., a geometric figure, but the reproduction is hidden from view, thereby preventing visual feedback in the ordinary sense. Thus, the subject is forced to rely solely on a mental picture when reproducing the object. Feedback can be provided so the subject can judge the accuracy of the reproduction by lifting a cover sheet on the Imagetics material which subsequently shows how the reproduction matches the standard. An objective of the technique is to provide a means for graphically recording students' responses which may stimulate and develop the students' ability to mentally visualize and recall previously presented material. Materials have been developed for (a) four different procedural tasks for the F-111D, 6883 Converter Flight Controls test station, involving equipment setup, checkout, power supply adjustment, and control settings, and (b) four deductive logic tasks involving block diagrams and flow diagrams.

**Impact/Utilization:** The 6883 imagery-based task materials have been experimentally evaluated against a control group. Preliminary results indicate that the imagery-based strategy produces significantly more recall of task functions during the early phases of training and appears to orient students to unfamiliar task environments much faster than does the control technique. Due to the limited availability of training equipment in general, the development of an inexpensive pretraining technique with apparently powerful learning and motivating capabilities can have an enormous impact on the efficiency and subsequent quality of training. This technique provides a breakthrough in paper-and-pencil training methodology through the provisions of feedback, interaction with materials, and controlled use of imagery. The strategies developed for improving memory and acquisition of information in performance-oriented and deductive logic tasks could become potentially significant CAI strategies.

# AFHRL RESOURCES

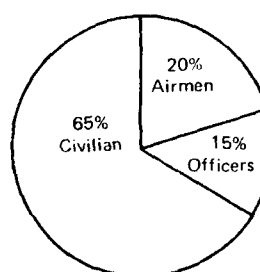


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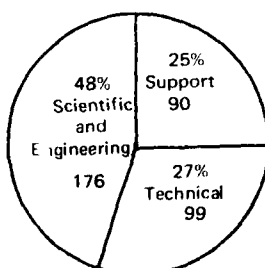
## PERSONNEL RESOURCES

### Authorized Personnel FY 79

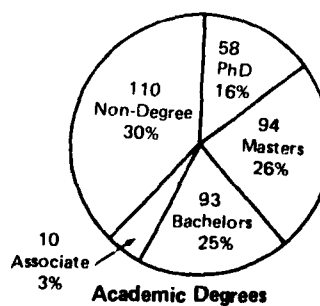
Officers	53
Airmen	74
Civilians	238
Total	365



Distribution of Authorized Personnel FY 79



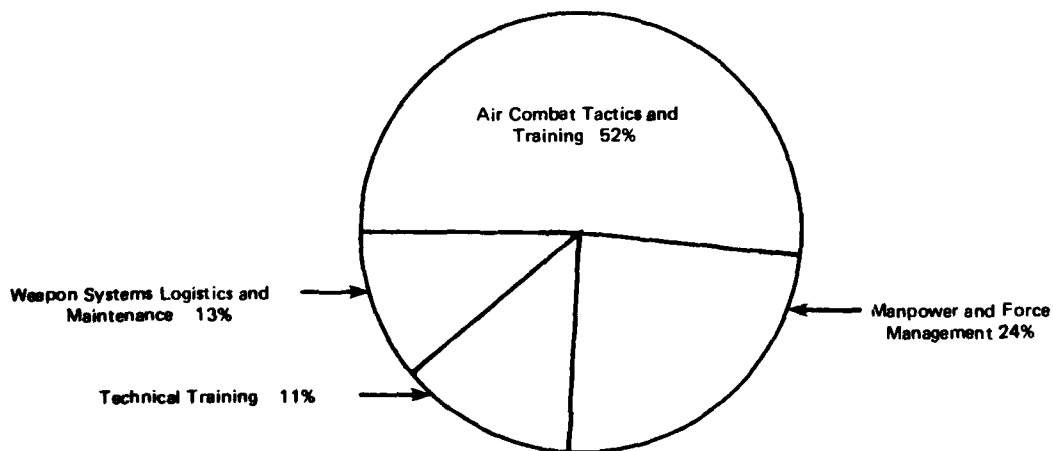
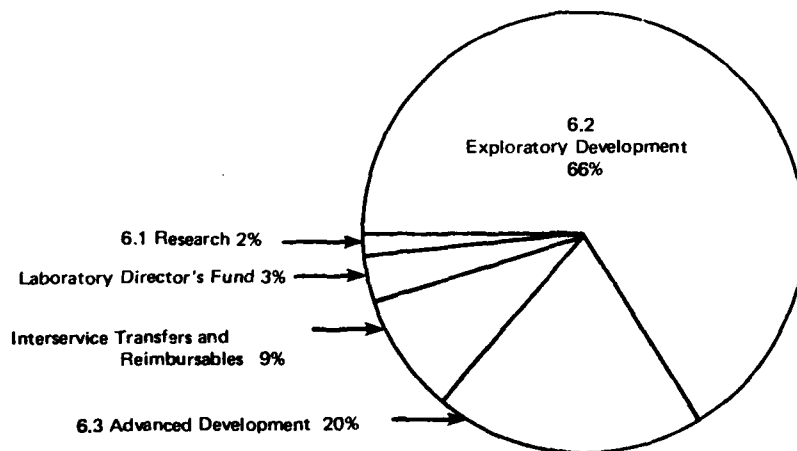
Personnel Type



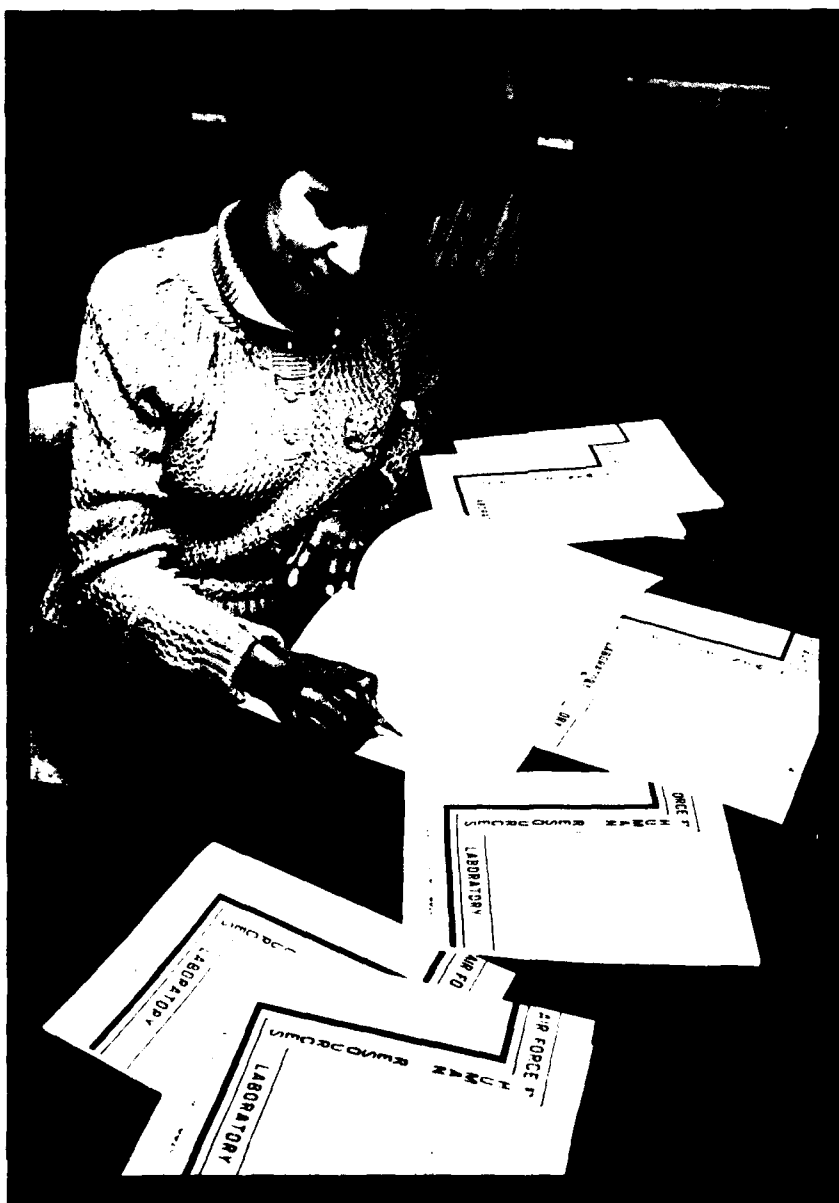
Academic Degrees

## FISCAL HIGHLIGHTS

Funding Summary (\$1,000)				
Funding Category	FY 77	FY 7T	FY 78	FY 79
Laboratory Director's Fund	\$ 405	\$ 105	\$ 450	\$ 720
Research (6.1)	556	26	429	575
Exploratory Development (6.2)	8,855	2,117	10,865	15,504
Advanced Development (6.3)	9,225	2,198	9,448	4,600
Interservice Transfers and Reimbursables	1,619	2	953	2,095
<b>Total</b>	<b>\$20,660</b>	<b>\$4,448</b>	<b>\$22,145</b>	<b>\$23,494</b>



# DOCUMENTATION AND PRESENTATIONS FY79



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- Albery, W.B., & Gum, D.R. Motion and Force Cueing Requirements and Techniques for Advanced Tactical Aircraft Simulation. AFHRL-TR-78-73, AD-A064 691.
- Alley, W.E. Vocational Interest-Career Examination: Use and Application in Counseling and Job Placement. AFHRL-TR-78-62, AD-A063 657.
- Ausburn, L.J. Impact of Learning Styles on Air Force Technical Training: Relationships Among Cognitive Style Factors and Perceptual Types. AFHRL-TR-78-91(I), AD-A069 443.
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- Martin, E.L., & Waag, W.L. Contributions of Platform Motion to Simulator Training Effectiveness: Study II—Aerobatics. AFHRL-TR-78-52, AD-A-64 305.
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- McManus, J.C. Equipment Comparability Techniques Used During Early System Design. AFHRL-TR-79-24, AD-A071 411.
- Meyer, R.P., Laveson, J.L., Paper, G.L., & Edwards, B.J. Development and Applications of a Task Taxonomy for Tactical Flying. AFHRL-TR-78-59, AD-A064 689.
- Monroe, E.G., et al. Advanced Simulator for Pilot Training (ASPT): Aerial Refueling Visual Simulation-Engineering Development. AFHRL-TR-78-51, AD-A063 283.
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- Titsworth, W.L. Differences Between Crosstrainees and Non-Crosstrainees on Grade Level, Job Satisfaction, and Assignment Characteristics. AFHRL-TR-79-4, AD-A069 587.
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- Adams, J.R., & Lawrence, E.P. Constructing and Validating Behavioral Measures of Women Entering the Military Craft Skills. *Proceedings of the 39th Annual National Academy of Management Symposium*, Atlanta, GA, 8-11 August 1979.
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- Bergmann, J.A., & Christal, R.E. Female Utilization in Non-Traditional Areas. *Proceedings, 20th Annual Conference of Military Testing Association*, Oklahoma City, OK, October-November 1978.
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- Alley, W.E. Survey Assessment of Lab Physical Requirements. 87th Annual American Psychological Association Convention, New York NY, September 1979.
- Askren, W.B. Human Resources and Logistics Factors in Design Modeling, and Life Cycle Costing of Air Force Weapon Systems. Electronic Industries Associates, Engineering Design Integration Committee, Dayton OH, 21 August 1979.
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- Toedt, D. Merit Pay and Related Appraisal Issues. Officer Effectiveness Ratings Committee, Brooks AFB TX, January 1979.
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- Toedt, D. Merit Pay. AFHRL Appraisal Conference and Work Group, Brooks AFB TX, March 1979.
- Toedt, D. Merit Pay and Civil Service Reform Act of 1978. Federal Executive Association Committee on Compensation, Brooks AFB TX, May 1979.
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- Valentine, L.D. Participant. 87th Annual American Psychological Association Convention. New York NY, September 1979.
- Ward, J.H. Development of Instructional Systems. Defense Language Institute, Lackland AFB TX, November 1978.
- Ward, J.H. Policy Capturing and Policy Specifying. Seminar on the Approach and Methodology for Gaining New Insight into Strategic Nuclear Survival, Washington DC, May 1979.
- Ward, J.H. Policy Specifying. Navy Personnel Research and Development Center, San Diego CA, July 1979.
- Ward, J.H. Interaction between People Characteristics and Job Properties. Navy Personnel Research and Development Center, San Diego CA, August 1979.
- Ward, J.H. Grouping and Prediction. CODAP Workshop, Brooks AFB TX, September 1979.
- Wilbourn, J.M. Development of a Promotion Potential Assessment System. AFLC Directors of Personnel Conference on Personnel, Kelly AFB TX, June 1979.

## TECHNICAL SYMPOSIA AND CONFERENCES

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In FY 79, AFHRL was the host or cohost of several professional symposia and conferences that brought together experts in many disciplines to report on new research, to discuss the findings of current projects, and to share ideas on common problems. The diversity of subjects covered by these meetings is shown by the following list:

January 1979	Tri-Service Meeting on Economics of Human Resources, San Antonio TX
July 1979	MAJCOM Conference on OJT R&D Planning, Lowry AFB CO
July 1979	DoD Education and Training Technical Advisory Group, Denver CO

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AIR FORCE HUMAN RESOURCES LAB BROOKS AFB TX

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AIR FORCE HUMAN RESOURCES LABORATORY ANNUAL REPORT - FISCAL YEA--ETC(U)

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**SUPPLEMENTARY**

**INFORMATION**

DEPARTMENT OF THE AIR FORCE  
AIR FORCE HUMAN RESOURCES LABORATORY (AFSC)  
BROOKS AIR FORCE BASE, TEXAS 78235



REPLY TO  
ATTN OF:

TSR

*Errata*

16 JAN 1981

SUBJECT: Removal of Export Control Statement

TO: Defense Technical Information Center  
Attn: DTIC/DDA (Mrs Crumbacker)  
Cameron Station  
Alexandria VA 22314

1. Please remove the Export Control Statement which erroneously appears on the Notice Page of the reports listed ~~████████████████████~~. This statement is intended for application to Statement B reports only.

2. Please direct any questions to AFHRL/TSR, AUTOVON 240-3877.

FOR THE COMMANDER

*Wendell L. Anderson*

WENDELL L. ANDERSON, Lt Col, USAF  
Chief, Technical Services Division

1 Atch  
List of Reports

Cy to: AFHRL/TSE

AD - A092839